Ministry of
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Ontario

REPORT EM-57

BITUMINOUS INTERLABORATORY STUDY 1981 MARSHALL MIX DESIGN AND MIX CONTROL

Engineering
Materials
Office

BITUMINOUS

INTERLABORATORY STUDY

1981

MARSHALL MIX DESIGN

AND

MIX CONTROL

by

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AND

COMMUNICATIONS

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BITUMINOUS SECTION

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SUMMARY

This report outlines the bituminous interlaboratory correlation program on mix design and mix control which was run in 1981. Some eighteen laboratories participated; ten M.T.C. labs (6 stationary and 4 mobile), five consultants, two municipal and one industry laboratory.

The design and statistical parameters are briefly discussed to explain to the participants the output and significance.

On several of the tests dramatic differences show up between MTC labs and the outside laboratories. Where possible these differences have been explained. In forming meaningful precision data it is not advisable to use this data until one is certain that all results are representative of the population. That is all laboratories must be competent, using the same test methods, on equipment that is designed for the test and operating within preset criteria.

It is very obvious that several of the laboratories will have to examine their procedures and equipment to eliminate the differences.

It is hoped that this report and subsequent annual correlation programs will promote increased awareness of the importance of a knowledge of precision in materials testing. One of the end products of this approach will be the derivation of meaningful precision statements for each test. Another end product will be the establishing of communication and co-operation between laboratories ultimately leading to improvements in the quality of Bituminous Materials Testing throughout the Province.

ACKNOWLEDGEMENTS

Without a lot of hard, tedious work by laboratory technicians all over Ontario, this report would not have been possible. A special thanks to the technicians in the Bituminous Mix Design and Preparation laboratories at Downsview for handling, sorting and preparing the samples for distribution. Special thanks to Dave Cole and Dave Carter who under Doug Hollinshead's supervision performed the bulk of the work involved in sample preparation and computer data input respectively.

Thanks also to the asphalt and aggregate producers who gave us the raw materials used in conducting this study.

INTRODUCTION

This is the second test period that testing has been carried out using this format of two materials and statistically based design. This method is an adaptation of the method developed by Manchester, 1979. In the past, correlations carried out by the Bituminous Section lacked the analysis and design which led to superficial results. It is expected by following this new format that sound precision limits and a more useful tool will be placed in the hands of the participants.

For a few of the participants some of the results and format of reporting will be new, but it is hoped that this report will explain the results and their significance.

A brief discussion on precision and accuracy, design of the test program and treatment and interpretation of the results preceeds the results of the program.

A few paragraphs give a brief interpretation of the variation in results for each test method. A reader well-versed in statistics with a thorough knowledge of the tests themselves may be able to add to the interpretations. However, the author warns those who are unfamiliar to not over interpret the results.

PRECISION AND ACCURACY

Precision is the degree of agreement between individual measurements on the same material. In this study, two kinds of precision have been investigated namely, Single Laboratory and Multi Laboratory. Definition of Single Operator, Single Laboratory and Multi Laboratory Precision are as follows:

Single Operator Precision. This is the maximum difference expected between two measurements on replicate samples of the same material tested by one operator. This value should be exceeded only about 1 time in 20 (i.e., 5% of the time).

Example: The single operator precision of the Coarse Aggregate Absorption test is about 0.2%, for materials within the range tested. If an operator is given two identical samples to test, he should not obtain a difference in absorption results of greater than 0.2%. Values of 1.15% and 1.05% are acceptable and fall within the expected precision of the test. Values of 0.8 and 1.1% exceed the precision limits for the test.

Single Laboratory Precision. This is the maximum difference expected between two measurements on replicate samples of the same material tested in one laboratory but not necessarily by the same operator. This value is usually larger than the single operator precision because different operators will have slightly different techniques.

Example: The single laboratory precision of the Bulk Relative Density test of compacted asphalt concrete is approximately 0.02 for materials within the range tested. If two replicate samples are tested in a laboratory, their relative densities should differ by no more than 0.02, 95% of the time. Thus 2.345 and 2.341 are a pair of values falling within the expected precision of the test, and 2.339 and 2.368 are not.

Multi-laboratory Precision. This is the maximum difference expected between two measurements on replicate samples of the same material tested in two different laboratories. This value is usually larger than the single laboratory precision because the different laboratories have different equipment, different operators, different environmental conditions, etc.

Example: If the multi-laboratory precision of the Voids in Mineral Aggregate test is approximately 1.1% for materials in the range tested. If two replicate samples are tested by different laboratories, their results should differ by no more than 1.1%, 95% of the time. Thus values of 6.9% and 7.0% are acceptable, and fall within the expected precision of the test, while values of 5.4% and 6.6% do not.

These types of precision described above are equivalent to the ASTM D2S index (difference two-sigma limit) described in ASTM C670-77.

By identifying three levels of precision (single operator, single laboratory and multi-laboratory) we can identify where the lack of precision is primarily caused. In some tests the lack of precision is probably caused by the differing operator techniques (more uniform training is called for). In other tests (i.e. #31, & #32, Marshall Stability & Flow) individual operator technique has little influence on the lack of precision of the test. In this test most of the lack of precision is caused by the different equipment used in each laboratory and the condition of the compaction equipment.

The precision values reported in this publication can be used as guides to determine whether a given series of results can be considered to be valid. Precision values should never be added to existing specification limits to be used as strict standards for accepting or rejecting materials (ASTM C670-77).

Accuracy refers to the degree of agreement of measurements with an accepted or 'true' level of the property in the material that was measured. A group of measurements can have high precision without being accurate.

If most of the measurements in a group are greater than the true value, or if most of them are less than the true value, then their distribution is said to be biased. The distortion is usually due to factors which have not been controlled in the planning or performance of the test. For example (to take an extreme case) if an operator leaves his cheese sandwich on the scale while he is weighing samples for the Absorption test, all the test results will be biased because the weights will be larger than they should be.

In bituminous testing, the true value which a material should obtain in a test cannot be known. Hence this investigation is about precision, correlation between laboratories and sources of error rather than with accuracy and bias. It is important, however, to understand the relationship between accuracy and precision.

Figure 1 shows the distribution of a group of results from the compressive strength test for concrete. Along the x axis are the compressive strengths of the samples, and along the y axis are the numbers of samples each having the same compressive strength. Although most of the results are close to the mean value, there is a lot of variation among them. The solid line represents a smooth curve which has been fitted to the data, and which can be used in mathematical calculations to present the actual distribution of the results. The curve in Figure 1 is called a normal curve, because of its shape and several other characteristics. There are many other types of curves which can be used to describe groups of measurements.

Figure 2 illustrates the meaning of the terms precision, accuracy and bias. This Interlaboratory Testing Program is being conducted in an effort to increase the precision of the groups of test results, which leads to a narrower curve describing the distribution. An increase in precision can be achieved by controlling the factors that contribute to this variation. Identification of these factors is the object of the interlaboratory testing program.

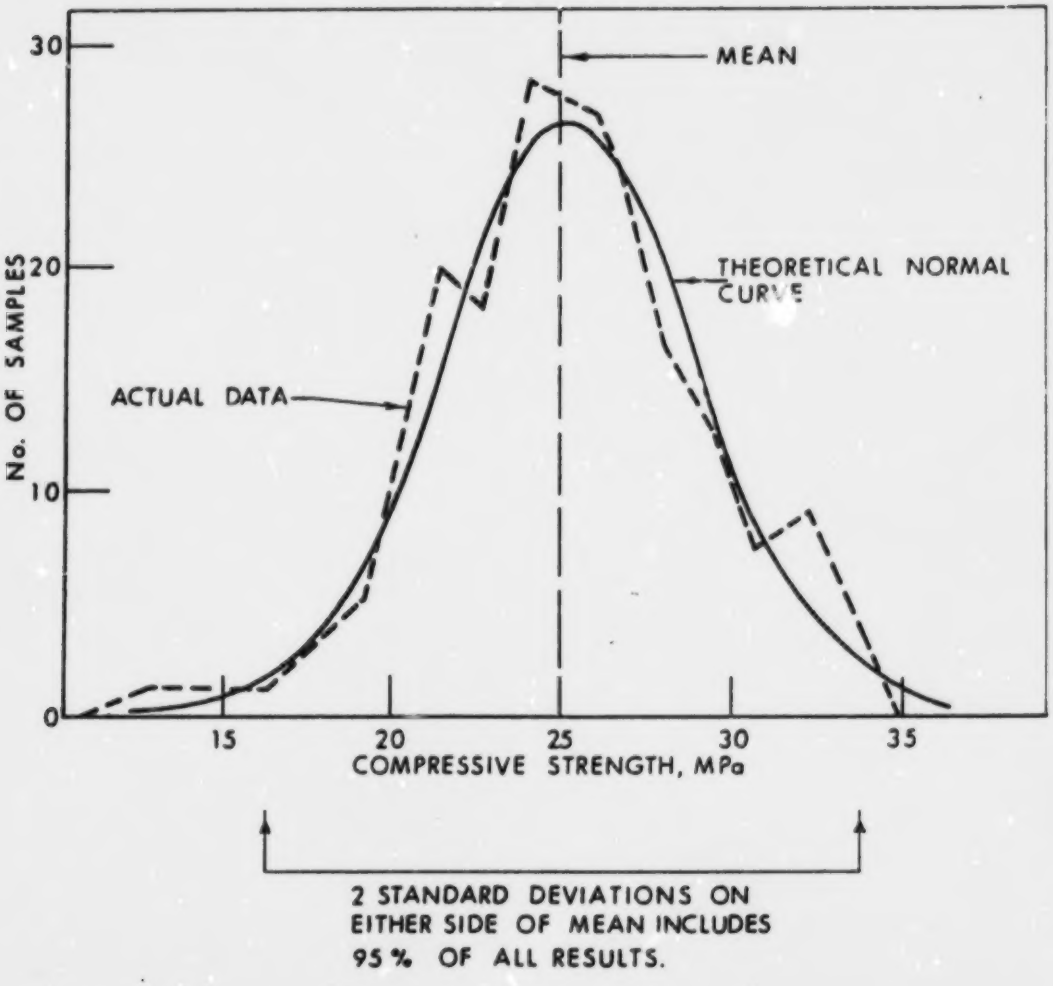

FIGURE 1: COMPRESSIVE STRENGTH OF 186 PAVEMENT CORES FROM A SINGLE PROJECT. THIS ILLUSTRATES THE DEVELOPMENT OF THE NORMAL CURVE AND THE VARIABILITY THAT CAN BE ENCOUNTERED. (ADAPTED FROM U.S.D.O.T., HIGHWAY QUALITY ASSURANCE PROJECT, CHAPTER 3).

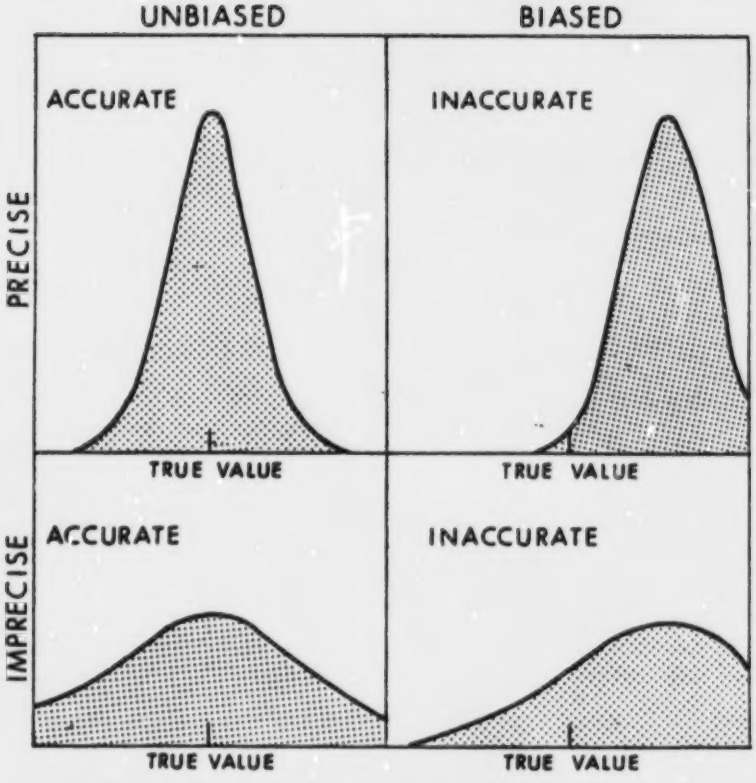

FIGURE 2: THIS DIAGRAM PRESENTS A PICTURE OF THE INTERRELATIONSHIP OF PRECISION, ACCURACY AND BIAS. A NARROW SPREAD IN TEST RESULTS SHOWN BY THE CURVE INDICATES A PRECISE TEST (ADAPTED FROM EISENHART, 1952).

DESIGN OF THE INTERLABORATORY TESTING PROGRAM

The design of this program follows as far as possible the guidelines set out in ASTM C802-77 (Conducting an Interlaboratory Test Program to Determine the Precision of Test Methods for Construction Materials). ASTM C802 recommends that there should be at least ten participating laboratories. Normally, for most tests, one sample is tested to arrive at a test result. Increasing the number of replicates improves the estimate of single operator and single laboratory precision but has no effect on the multi-laboratory precision.

The basic structures of this interlaboratory program are the test period and the unit block. A test period begins when a batch of samples is sent out to the labs for testing, and ends when the next batch is sent out. A unit block (Youden, 1967) is a pair of materials, deliberately chosen so that their results on the various tests will be as close as possible.

In this project (test period 81) a pair of mix designs and a pair of premixed samples were studied. To accomplish this, aggregates were collected from several different sources in Southern Ontario.

The design distribution and randomisation of the samples is described in Appendix 'C' and 'D' of EM Report No.47.

When comparing results of the same test performed on different materials, it should be remembered that each material has its own set of "interfering properties" (Mandel, 1959). Therefore, groups of results obtained from a test performed under identical conditions on different materials will have not only different means but may have very different precision as well.

TREATMENT AND INTERPRETATION OF RESULTS

When the reports were received from the various laboratories the calculations were checked, the results tabulated and key punched. The reason for checking some of the calculations was because errors had been made. The wrong formula had sometimes been used, decimal points were in the wrong place, etc.

After checking the keypunched data cards, the computer program LA 37103 was run and results printed out. In the description of results for each test method, only some of the statistical results have been reproduced. Information such as analyses of variance and performance summaries of the individual laboratories have been omitted. The data available to draw conclusions is somewhat limited and not considered valid at this stage.

For most test methods, four items are included in this report. They are: a table of test results, a table of within-laboratory averages, a table of variation of precision with level and a scatter diagram for each test method.

Table of Test Results

These are the test results reported in the case of the mix parameters as the average of the groups of three briquettes and in the case of mix control as the raw data from each laboratory for each test.

Table of Within-Laboratory Averages

These are the average of the two test results reported by each laboratory together with the standard deviation. The standard deviation for Laboratory 12 is invalid for the mix design tests as only one set of three briquettes was submitted for each material.

Table of Estimates of Precision

The form of precision calculated for each material are: the 95% difference limit and the equivalent ASTM D2S limit where applicable. The 95% difference limit is a number which should be exceeded, on the average, no more than one time in twenty by the difference between the test results in the group to which the precision statement applies. Thus, for example, if the single laboratory 95% difference limit is 3.5, then two test results done by the same operator on the same material should differ by no more than 3.5, 95% of the time.

It must be remembered that the numbers in the table are only estimates of precision, and apply only to the population of laboratories from whose results they were calculated, and at the time when they were calculated.

Scatter Diagram

The fourth item is a scatter diagram. This is included in the main body of the text because it gives a quick, easily understood picture of the precision and extent of systematic variation. The horizontal axis of the scatter diagram represents test results for material 1, and the vertical axis represents test results for material 2. The axes intersect at a point whose coordinates are the means of the test results on materials 1 and 2.

The points on the graph represent the average of the laboratories participating in the test. The two axes have the same scale. In the computer program the axis length for each test method is chosen by the user.

The "special character" codes are interpreted as follows:

Ɛ = two operator points in this space.

\# = three operator points in this space.

? = more than three operator points in this space.

* = This operator's point is off the graph - one of its co-ordinates is greater or less than the limits printed at the end of the axes - see table of operator averages for the values of the co-ordinates of the points.

Not all of these codes will necessarily appear, as some labs may be missing.

The scatter diagram is a rough measure of the amount of agreement which exists among the laboratories, and between the operators in the laboratories. If all the points are bunched closely about the intersection of the two axes, the test results have a high precision. If the points are scattered widely about the intersection of the axes, then the test results have a low precision.

If the number of points in the four quadrants are approximately equal, then there is little evidence of systematic differences among the labs, and most of the variation in the test results is probably due to purely random error. Evidence of systematic differences between the labs is provided by a pattern of points forming an elliptical band from the lower left to the upper right hand corner of the scatter diagram. The longer and narrower the band, the more pronounced the differences. Thus a scatter diagram which reflects the ideal situation in an interlaboratory study - a precise test method with little systematic differences between laboratories - has the points gathered very closely about the intersection of the axes and approximately equal numbers of points in each quadrant.

This scatter diagram analysis was invented by Youden (1959). An excellent description of the technique and the interpretation of its results is given in Benson (1975, pp.7-19).

Variation of Precision With Level

This table has been included in the discussion of each test method in the body of the report. Generally as the level of a measured property increases the values become less precise (i.e., the precision values become larger). The single laboratory and nonparametric multi-laboratory precision values obtained in test period 1 are printed for the two levels of a property that has been investigated. In future test periods, it is hoped to cover other test values for each test method so a complete picture of precision against normally encountered test values is obtained.

Where there is an equivalent ASTM Precision statement this has been included on the table for comparison.

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TEST RESULTS AND DISCUSSION

Marshall Mix Design Tests

Several of the mix design tests are dependent on the results of other tests, analyzing the data therefore should take this into account.

The raw ingredients and recipes for two mixes were issued to each laboratory. The laboratory was then instructed to grade the aggregates and recombine to the recipe. The mixture at a preset asphalt content was then processed through each laboratory and the test data reported for six briquettes of each of two materials. Laboratories 2, 12 and 13 however only reported the results of three briquettes for each of the two mixes. In order to plot and utilize their data a duplicate set of results was used thus their internal standard deviations are not valid.

WEIGH CARD Mix 'A'

DATE Jan. 28/81 CONTRACT NO. Correl'n '81

% PASS 4.75 mm	% COARSE AND % FINE AGG.	COARSE AGG. GRAD. % CUMULATIVE 1 / COARSE AGG. WT. @ CUMULATIVE 2	COARSE AGGREGATE, 'A' 19.0 mm	16.0 mm	13.2 mm	9.5 mm	6.7 mm	4.75 mm	Pass 4.75 mm	FINE, 'A' AGGREGATE NO. 1 BLEND	FINE AGGREGATE NO. 2 BLEND		% A.C.
		1				31.5	76.5	95.2					
55	44.4 / 55.6	2				531	1291	1606	1687	3800			5.1
		2											
		2											
		2											
		2											

ASPHALT SOURCE & GRADE (PENETRATION) AS SUPPLIED IN CORREL'N MIX TYPE

REMARKS

WEIGH CARD Mix 'B'

DATE Jan. 28/81

CONTRACT NO. Correl'n '81

% PASS 4.75 mm	% COARSE AND % FINE AGG.	COARSE AGG. GRAD. % CUMULATIVE 1 / COARSE AGG. WT. g CUMULATIVE 2	COARSE AGGREGATE, 'B'							FINE, 'B' AGGREGATE NO. 1	FINE AGGREGATE NO. 2		% A.C.
			19.0 mm	16.0 mm	13.2 mm	9.5 mm	6.7 mm	4.75 mm	Pass 4.75 mm				
		1			2.8	37.3	70.7	89.5		BLEND	BLEND		
55	47.4 / 52.6	2			50	672	1273	1612	1801	3800			5.2
		2											
		2											
		2											
		2											

ASPHALT SOURCE & GRADE (PENETRATION) AS SUPPLIED IN CORREL'N MIX TYPE

REMARKS

Test 25: Bulk Relative Density of Compacted Hot Mix

Method MTC LS-262

Reference ASTM D2726-73

This test is run on a compacted asphalt concrete mix specimen. The specimen simulates the "best" compacted density for that combination of aggregates and asphalt cement. If the sample is not compacted enough, because of equipment or temperature problems, the air voids will not simulate the 100% compaction condition. This then would lead to a serious design error which could lead to flushed pavements. Eighteen laboratories participated in this test.

In the scatter diagram with all the labs included we notice a high evidence of systematic error. However the majority of laboratories clustered in the upper right quadrant are MTC laboratories. Only lab O appears to be part of that group. When the MTC labs are run through the computer program alone, we notice that the single and multi-laboratory precision limits are improved. The new means are 0.016 and 0.013 higher than the means of all the labs together. Laboratories 'K' to 'R' with the exception of lab 'O' should investigate their equipment and/or procedures in order to improve the bulk relative densities provided by their equipment.

TEST 25: HOT MIX, BULK RELATIVE DENSITY
TEST PERIOD: 81

TABLE OF TEST RESULTS

	MATERIAL 1		MATERIAL 2	
LAB 1 OPERATOR 1	2.427	2.428	2.415	2.416
LAB 2 OPERATOR 1	2.415	2.415	2.406	2.406
LAB 3 OPERATOR 1	2.422	2.426	2.397	2.398
LAB 4 OPERATOR 1	2.425	2.428	2.409	2.413
LAB 5 OPERATOR 1	2.434	2.434	2.413	2.413
LAB 6 OPERATOR 1	2.408	2.411	2.412	2.421
LAB 7 OPERATOR 1	2.420	2.419	2.415	2.411
LAB 8 OPERATOR 1	2.433	2.431	2.414	2.414
LAB 9 OPERATOR 1	2.418	2.422	2.391	2.408
LAB 10 OPERATOR 1	2.422	2.422	2.414	2.412
LAB 11 OPERATOR 1	2.399	2.382	2.366	2.324
LAB 12 OPERATOR 1	2.402	2.402	2.385	2.385
LAB 13 OPERATOR 1	2.351	2.351	2.331	2.331
LAB 14 OPERATOR 1	2.394	2.404	2.395	2.397
LAB 15 OPERATOR 1	2.418	2.415	2.402	2.402
LAB 16 OPERATOR 1	2.390	2.400	2.389	2.394
LAB 17 OPERATOR 1	2.400	2.403	2.361	2.365
LAB 18 OPERATOR 1	2.387	2.387	2.374	2.379
RANGES	0.083		0.097	

TEST 23: HOT MIX, BULK RELATIVE DENSITY
TEST PERIOD: 81

WITHIN-LABORATORY AVERAGES AND STANDARD DEVIATIONS

LAB	AVERAGE	SIGMA
MATERIAL 1		
LAB 1	2.427	0.002
LAB 2	2.415	0.002
LAB 3	2.424	0.003
LAB 4	2.426	0.003
LAB 5	2.434	0.000
LAB 6	2.409	0.003
LAB 7	2.419	0.000
LAB 8	2.432	0.003
LAB 9	2.420	0.003
LAB 10	2.422	0.002
LAB 11	2.390	0.012
LAB 12	2.402	0.001
LAB 13	2.351	0.001
LAB 14	2.399	0.007
LAB 15	2.416	0.002
LAB 16	2.395	0.007
LAB 17	2.401	0.002
LAB 18	2.387	0.002
MATERIAL 2		
LAB 1	2.415	0.002
LAB 2	2.406	0.002
LAB 3	2.397	0.002
LAB 4	2.411	0.003
LAB 5	2.413	0.001
LAB 6	2.416	0.006
LAB 7	2.413	0.003
LAB 8	2.414	0.001
LAB 9	2.399	0.012
LAB 10	2.413	0.001
LAB 11	2.345	0.030
LAB 12	2.385	0.000
LAB 13	2.331	0.002
LAB 14	2.396	0.003
LAB 15	2.402	0.001
LAB 16	2.391	0.004
LAB 17	2.363	0.004
LAB 18	2.376	0.004

TEST 25: HOT MIX BULK RELATIVE DENSITY

TYPE OF PRECISION	MEAN TEST VALUES		
	Correlation 2.394	2.410	ASTM
Single Laboratory 95% Difference Limit	0.023	0.012	0.020
Multi Laboratory 95% Difference Limit	0.082	0.067	not available

Table Precision over a range of values.
ALL LABORATORIES

TEST 25

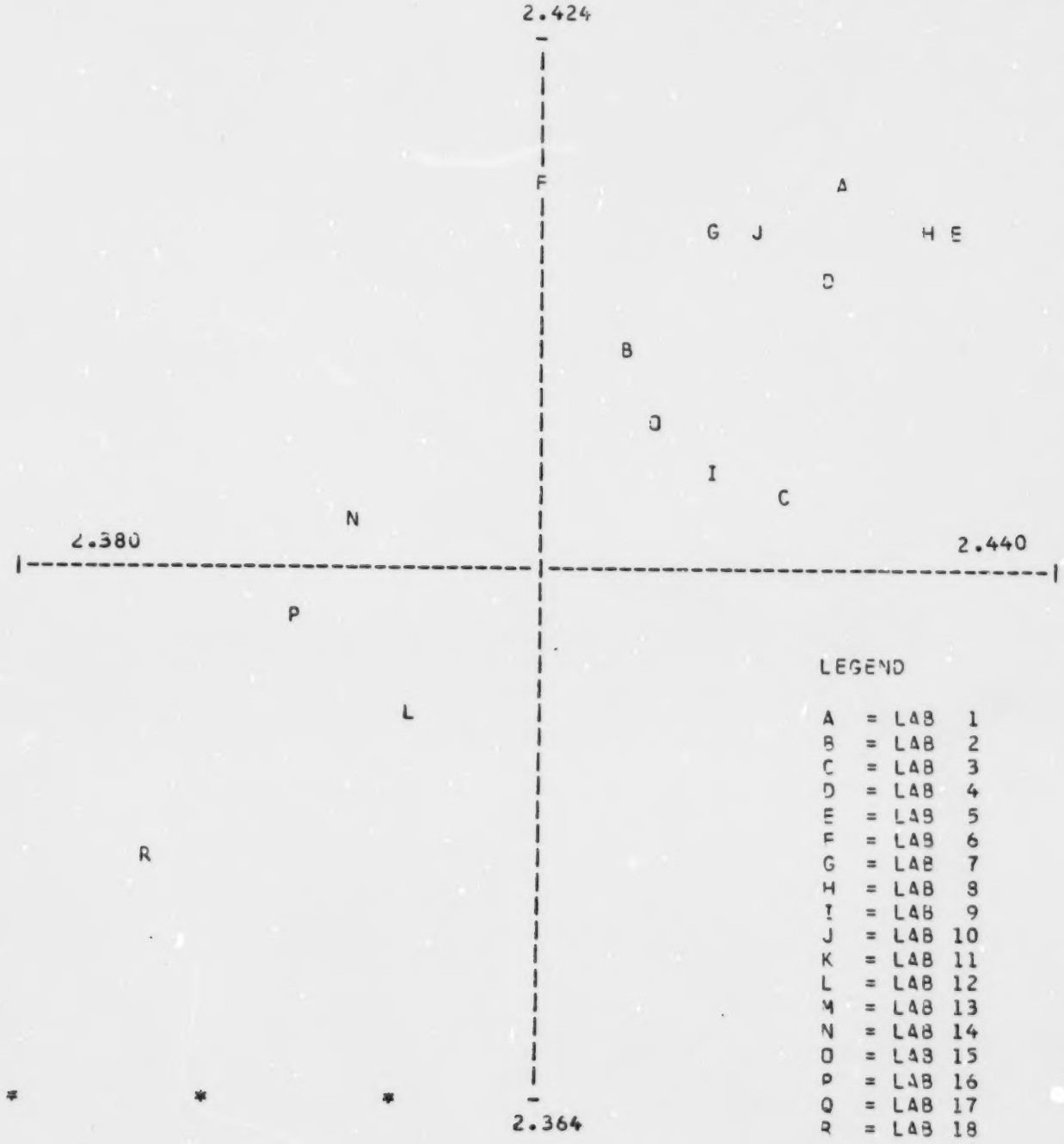
TYPE OF PRECISION	MEAN TEST VALUES		
	Correlation 2.410	2.423	ASTM
Single Laboratory 95% Difference Limit	0.013	0.007	0.020
Multi Laboratory 95% Difference Limit	0.022	0.020	not available

Table Precision over a range of values.
MTC LABS ONLY

TEST 25: HOT MIX, BULK RELATIVE DENSITY
TEST PERIOD: 81

SCATTER PLOT ANALYSIS
SCALE: 0.003 UNITS=1 CM

HORIZONTAL AXIS: MATERIAL 1
VERTICAL AXIS: MATERIAL 2



LEGEND

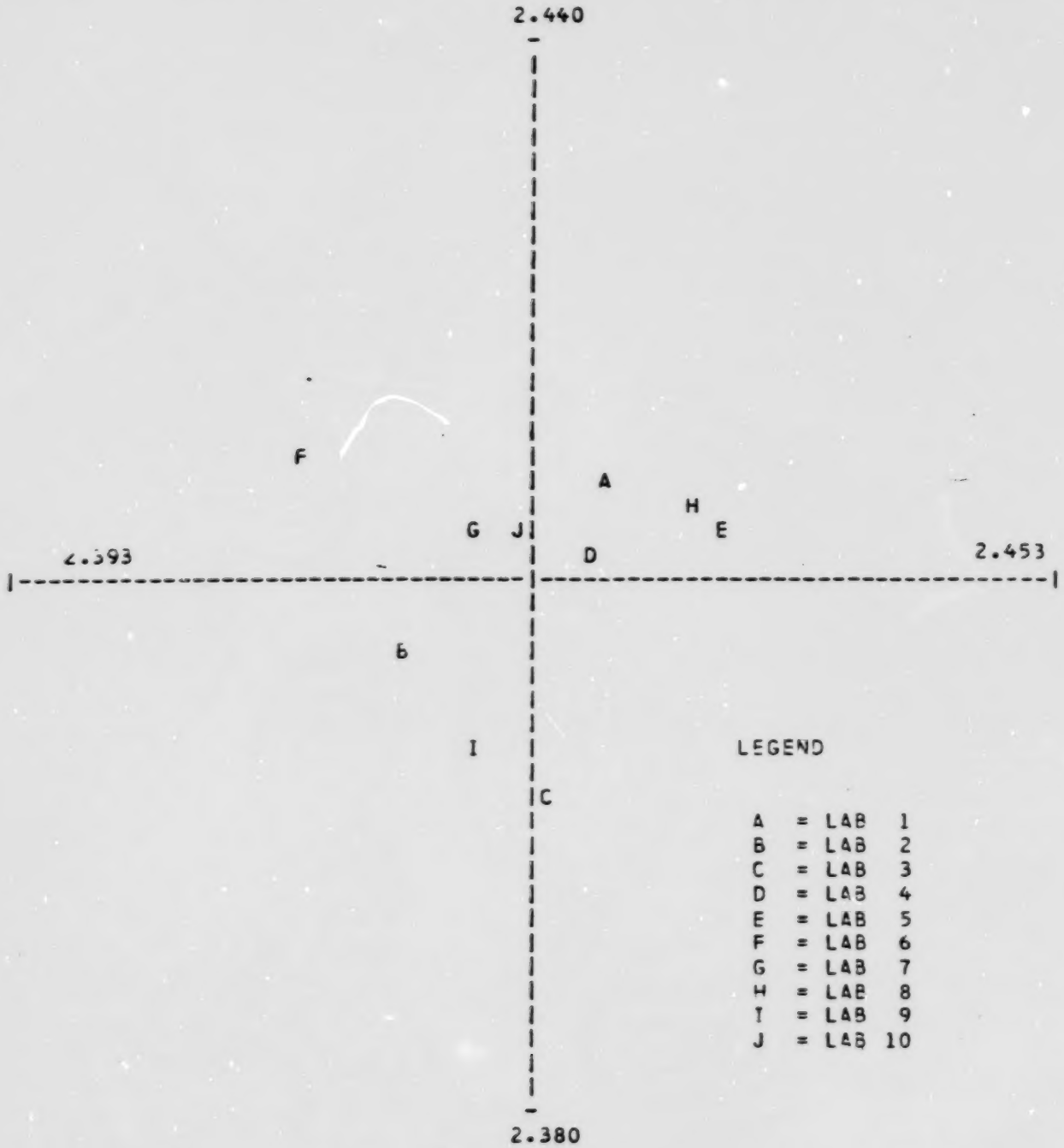
A	=	LAB 1
B	=	LAB 2
C	=	LAB 3
D	=	LAB 4
E	=	LAB 5
F	=	LAB 6
G	=	LAB 7
H	=	LAB 8
I	=	LAB 9
J	=	LAB 10
K	=	LAB 11
L	=	LAB 12
M	=	LAB 13
N	=	LAB 14
O	=	LAB 15
P	=	LAB 16
Q	=	LAB 17
R	=	LAB 18

	MATERIAL 1	MATERIAL 2
MEAN	2.410	2.394
STANDARD DEVIATION	0.021	0.026
STANDARD ERROR OF THE MEAN	0.003	0.004

TEST #5: HOT MIX, BULK RELATIVE DENSITY MTC LABS ONLY
TEST PERIOD: 31

SCATTER PLOT ANALYSIS
SCALE: 0.005 UNITS=1 CM

HORIZONTAL AXIS: MATERIAL 1
VERTICAL AXIS: MATERIAL 2



LEGEND

A	=	LAB 1
B	=	LAB 2
C	=	LAB 3
D	=	LAB 4
E	=	LAB 5
F	=	LAB 6
G	=	LAB 7
H	=	LAB 8
I	=	LAB 9
J	=	LAB 10

	MATERIAL 1	MATERIAL 2
MEAN	2.423	2.410
STANDARD DEVIATION	0.008	0.008
STANDARD ERROR OF THE MEAN	0.002	0.002

Test 26: Hot Mix Maximum Relative Density

Method MTC LS-264

Reference ASTM D2041-78

This test determines the ratio of the mass of a given volume of material @ 25°C to the mass of an equal volume of water at the same temperature. Again eighteen laboratories have participated in this test.

The differences between MTC and outside laboratories are not as dramatic as in test 25 but the inclusion of all laboratories moves the precision limits outside the ASTM D2S limits.

The scatter diagram and precision limits for MTC alone is also included for comparison purposes. The scatter diagram for the MTC ONLY shows a pattern of systematic error, that is a lab getting a low or high value on one material is highly likely to do the same on the other material.

TEST 26: HOT MIX, MAXIMUM RELATIVE DENSITY
TEST PERIOD: 81

TABLE OF TEST RESULTS

	MATERIAL 1		MATERIAL 2	
LAB 1 OPERATOR 1	2.520	2.523	2.491	2.493
LAB 2 OPERATOR 1	2.517	2.517	2.496	2.496
LAB 3 OPERATOR 1	2.504	2.509	2.471	2.477
LAB 4 OPERATOR 1	2.519	2.522	2.490	2.495
LAB 5 OPERATOR 1	2.518	2.524	2.504	2.494
LAB 6 OPERATOR 1	2.522	2.522	2.494	2.494
LAB 7 OPERATOR 1	2.520	2.520	2.492	2.492
LAB 8 OPERATOR 1	2.506	2.508	2.481	2.482
LAB 9 OPERATOR 1	2.512	2.520	2.483	2.492
LAB 10 OPERATOR 1	2.508	2.512	2.481	2.488
LAB 11 OPERATOR 1	2.518	2.495	2.498	2.536
LAB 12 OPERATOR 1	2.507	2.507	2.501	2.501
LAB 13 OPERATOR 1	2.497	2.497	2.474	2.474
LAB 14 OPERATOR 1	2.513	2.502	2.487	2.479
LAB 15 OPERATOR 1	2.500	2.501	2.482	2.501
LAB 16 OPERATOR 1	2.491	2.506	2.486	2.483
LAB 17 OPERATOR 1	2.528	2.523	2.485	2.488
LAB 18 OPERATOR 1	2.514	2.509	2.491	2.483
RANGES	0.037		0.065	

TEST 20: HOT MIX, MAXIMUM RELATIVE DENSITY
TEST PERIOD: 81

WITHIN-LABORATORY AVERAGES AND STANDARD DEVIATIONS

LAB	AVERAGE	SIGMA
MATERIAL 1		
LAB 1	2.521	0.002
LAB 2	2.517	0.000
LAB 3	2.506	0.004
LAB 4	2.520	0.003
LAB 5	2.521	0.005
LAB 6	2.522	0.002
LAB 7	2.520	0.002
LAB 8	2.507	0.002
LAB 9	2.516	0.006
LAB 10	2.510	0.003
LAB 11	2.506	0.016
LAB 12	2.507	0.002
LAB 13	2.497	0.002
LAB 14	2.507	0.008
LAB 15	2.500	0.001
LAB 16	2.498	0.011
LAB 17	2.525	0.004
LAB 18	2.511	0.004
MATERIAL 2		
LAB 1	2.492	0.003
LAB 2	2.496	0.001
LAB 3	2.474	0.005
LAB 4	2.492	0.004
LAB 5	2.499	0.007
LAB 6	2.494	0.001
LAB 7	2.492	0.002
LAB 8	2.481	0.003
LAB 9	2.487	0.007
LAB 10	2.484	0.005
LAB 11	2.517	0.027
LAB 12	2.501	0.001
LAB 13	2.474	0.001
LAB 14	2.483	0.006
LAB 15	2.491	0.013
LAB 16	2.484	0.002
LAB 17	2.486	0.003
LAB 18	2.487	0.006

TEST 26: HOT MIX MAXIMUM RELATIVE DENSITY

TYPE OF PRECISION	MEAN TEST VALUES		
	Correlation 2.490	2.512	ASTM
Single Laboratory 95% Difference Limit	0.023	0.016	0.011
Multi Laboratory 95% Difference Limit	0.035	0.026	0.019

Table Precision over a range of values.
ALL LABORATORIES

TEST 26

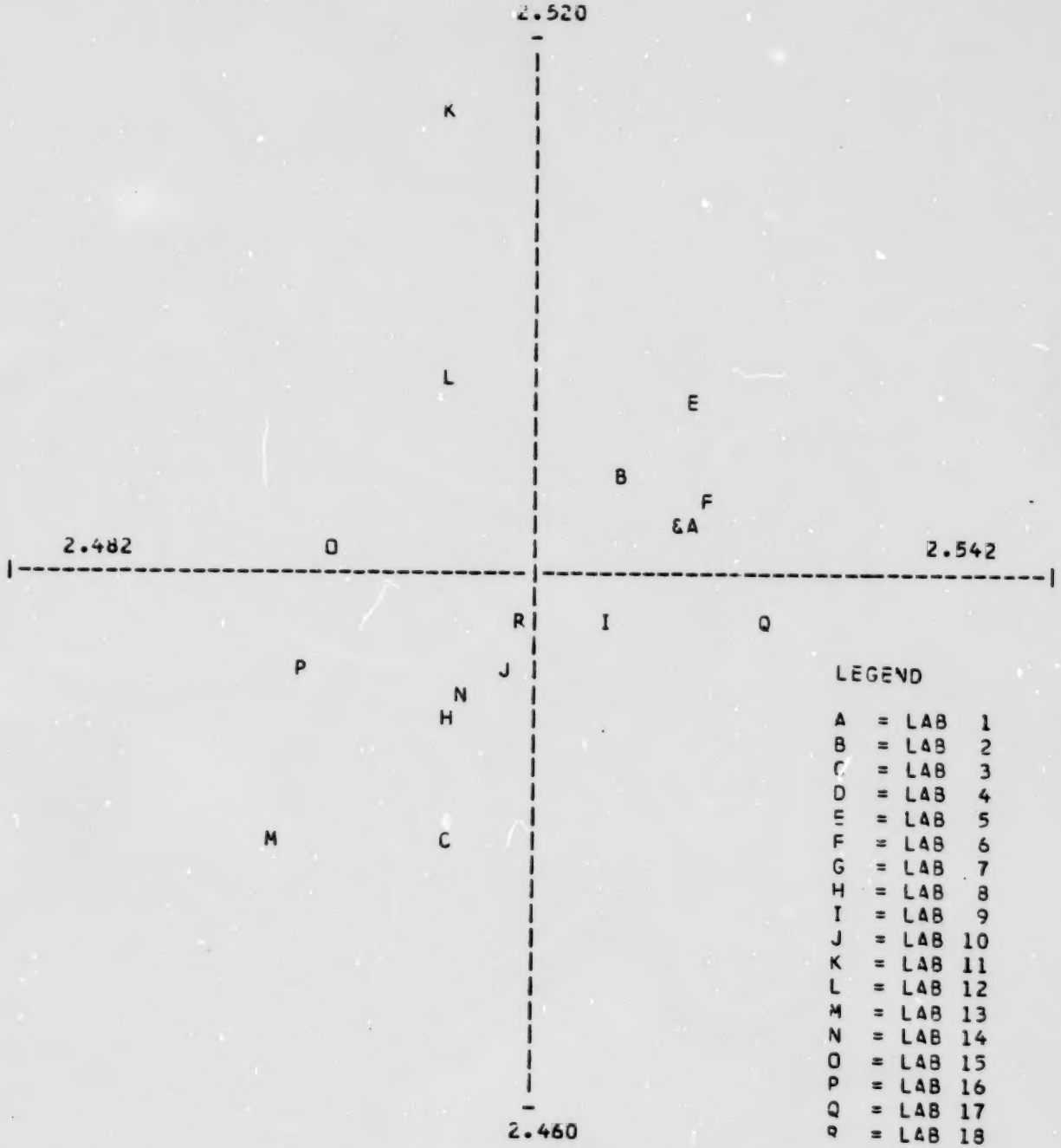
TYPE OF PRECISION	MEAN TEST VALUES		
	Correlation 2.489	2.516	ASTM
Single Laboratory 95% Difference Limit	0.012	0.009	0.011
Multi Laboratory 95% Difference Limit	0.023	0.016	0.019

Table Precision over a range of values.
MTC LABS ONLY

TEST 26: HOT MIX, MAXIMUM RELATIVE DENSITY
TEST PERIOD: 01

SCATTER PLOT ANALYSIS
SCALE: 0.003 UNITS=1 CM

HORIZONTAL AXIS: MATERIAL 1
VERTICAL AXIS: MATERIAL 2

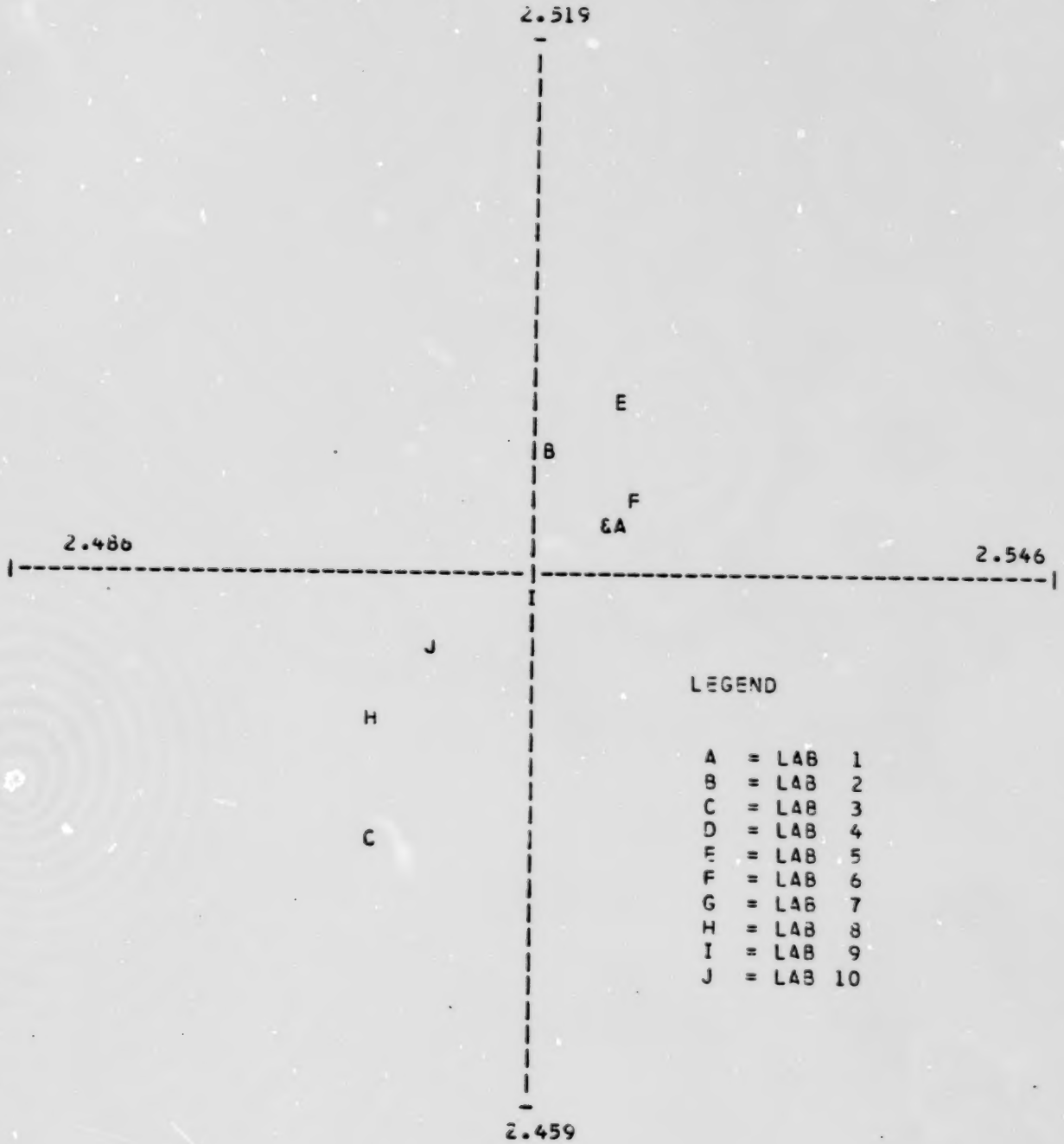


	MATERIAL 1	MATERIAL 2
MEAN	2.512	2.490
STANDARD DEVIATION	0.010	0.012
STANDARD ERROR OF THE MEAN	0.002	0.002

TEST 26: HOT MIX, MAXIMUM RELATIVE DENSITY MTC LABS ONLY
TEST PERIOD: 81

SCATTER PLOT ANALYSIS
SCALE: 0.003 UNITS=1 CM

HORIZONTAL AXIS: MATERIAL 1
VERTICAL AXIS: MATERIAL 2



	MATERIAL 1	MATERIAL 2
MEAN	2.516	2.489
STANDARD DEVIATION	0.007	0.009
STANDARD ERROR OF THE MEAN	0.002	0.002

Test 27: Hot Mix Maximum Relative Density (S.D.)

Method MTC LS-264

Reference ASTM D2041-78

This test corrects the maximum relative density for any moisture that is absorbed through the asphalt film or poorly coated particles which would have occurred under the vacuum saturation process.

Twelve laboratories participated on this test. A similar pattern as in Test 25 shows up on the scatter diagram the MTC labs fall within the upper right quadrant. This time labs 'L' and possibly 'O' might be considered to be part of this same population.

The precision limits of all labs together are within the ASTM D2S limits, however when compared with those of MTC ONLY are not as precise.

The MTC ONLY scatter diagram does not have the systematic pattern that Test 26 has.

TEST 27: HOT MIX, MAXIMUM RELATIVE DENSITY (SD)
TEST PERIOD: 81

TABLE OF TEST RESULTS

	MATERIAL 1		MATERIAL 2	
LAB 1 OPERATOR 1	2.496	2.502	2.472	2.474
LAB 2 OPERATOR 1	2.493	2.493	2.476	2.476
LAB 4 OPERATOR 1	2.496	2.497	2.463	2.469
LAB 6 OPERATOR 1	2.490	2.496	2.464	2.465
LAB 7 OPERATOR 1	2.488	2.486	2.463	2.462
LAB 10 OPERATOR 1	2.491	2.479	2.464	2.466
LAB 12 OPERATOR 1	2.492	2.492	2.473	2.473
LAB 13 OPERATOR 1	2.464	2.464	2.424	2.424
LAB 14 OPERATOR 1	2.478	2.465	2.449	2.442
LAB 15 OPERATOR 1	2.483	2.478	2.467	2.487
LAB 17 OPERATOR 1	2.486	2.482	2.450	2.455
LAB 18 OPERATOR 1	2.470	2.481	2.444	2.453
RANGES	0.038		0.063	

TEST #7: HOT MIX, MAXIMUM RELATIVE DENSITY (SD)
TEST PERIOD: 81

WITHIN-LABORATORY AVERAGES AND STANDARD DEVIATIONS

LAB	AVERAGE	SIGMA
MATERIAL 1		
LAB 1	2.499	0.004
LAB 2	2.495	0.002
LAB 4	2.496	0.000
LAB 6	2.496	0.001
LAB 7	2.487	0.002
LAB 10	2.485	0.008
LAB 12	2.492	0.002
LAB 13	2.464	0.001
LAB 14	2.471	0.009
LAB 15	2.480	0.004
LAB 17	2.484	0.003
LAB 18	2.475	0.008
MATERIAL 2		
LAB 1	2.473	0.001
LAB 2	2.476	0.001
LAB 4	2.466	0.004
LAB 6	2.464	0.000
LAB 7	2.462	0.001
LAB 10	2.465	0.002
LAB 12	2.473	0.000
LAB 13	2.424	0.000
LAB 14	2.445	0.005
LAB 15	2.477	0.014
LAB 17	2.452	0.004
LAB 18	2.448	0.006

TEST 27: HOT MIX MAXIMUM RELATIVE DENSITY S.D.

TYPE OF PRECISION	MEAN TEST VALUES		
	Correlation 2.461	2.485	ASTM
Single Laboratory 95% Difference Limit	0.014	0.014	0.018
Multi Laboratory 95% Difference Limit	0.048	0.043	0.055

Table Precision over a range of values.
ALL LABORATORIES

TEST 27

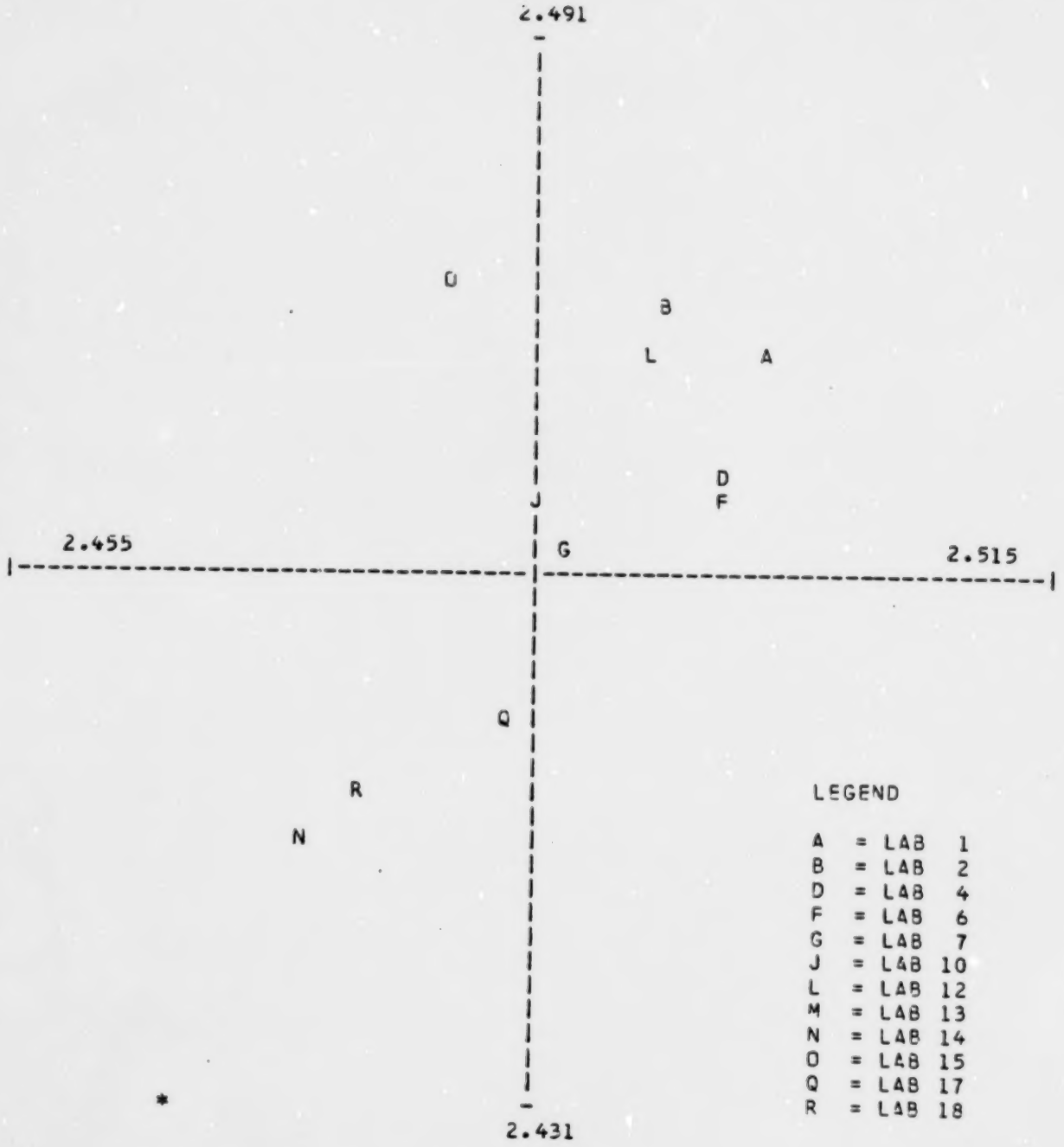
TYPE OF PRECISION	MEAN TEST VALUES		
	Correlation 2.468	2.493	ASTM
Single Laboratory 95% Difference Limit	0.006	0.011	0.018
Multi Laboratory 95% Difference Limit	0.013	0.017	0.055

Table Precision over a range of values.
MTC LABS ONLY

TEST 27: HOT MIX, MAXIMUM RELATIVE DENSITY (SD)
TEST PERIOD: 81

SCATTER PLOT ANALYSIS
SCALE: 0.003 UNITS=1 CM

HORIZONTAL AXIS: MATERIAL 1
VERTICAL AXIS: MATERIAL 2

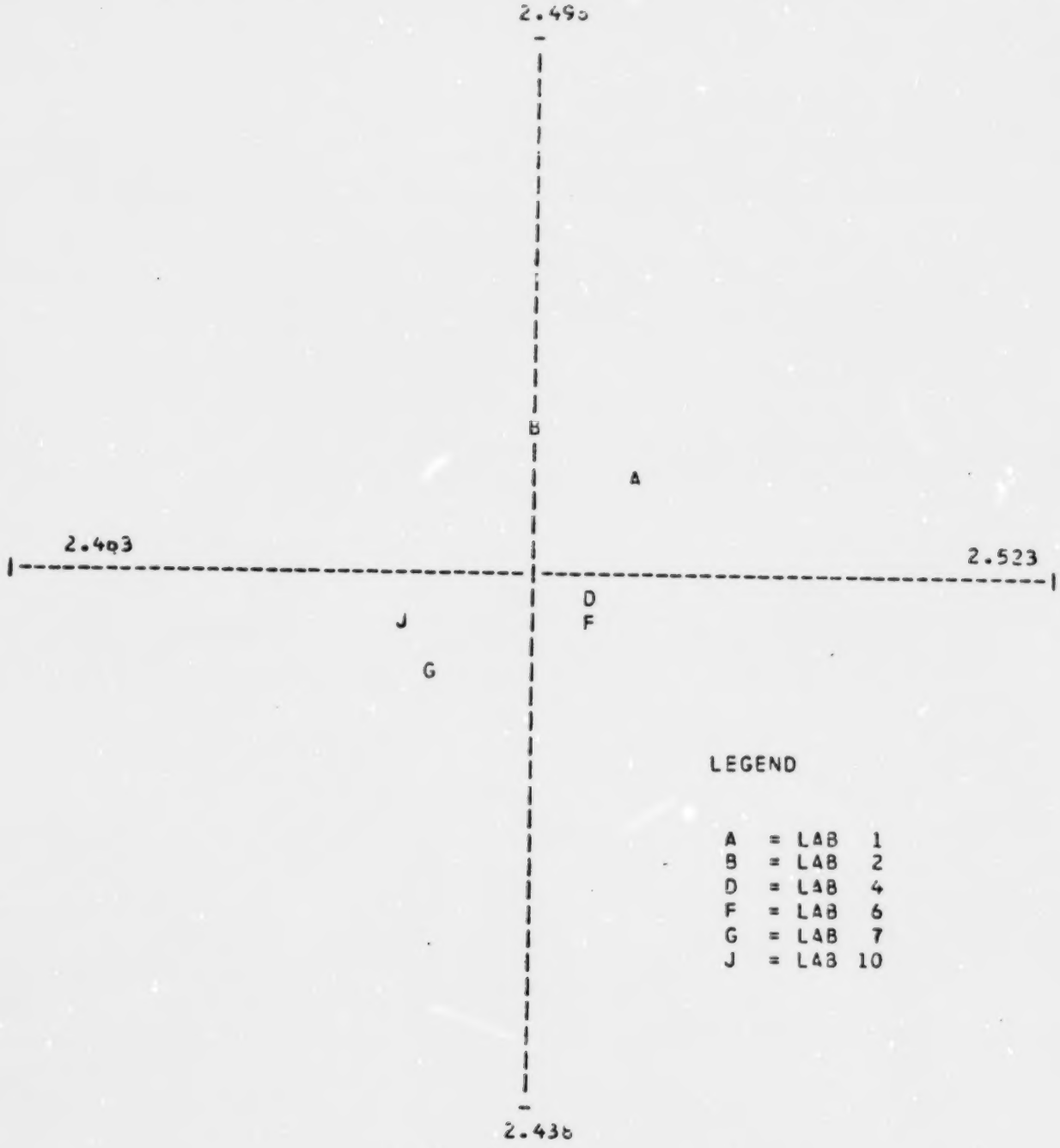


	MATERIAL 1	MATERIAL 2
MEAN	2.485	2.461
STANDARD DEVIATION	0.012	0.016
STANDARD ERROR OF THE MEAN	0.002	0.003

TEST 27: HOT MIX, MAXIMUM RELATIVE DENSITY (SD) MTC LABS ONLY
TEST PERIOD: 81

SCATTER PLOT ANALYSIS
SCALE: 0.005 UNITS=1 CM

HORIZONTAL AXIS: MATERIAL 1
VERTICAL AXIS: MATERIAL 2



LEGEND

A = LAB 1
B = LAB 2
D = LAB 4
F = LAB 6
G = LAB 7
J = LAB 10

	MATERIAL 1	MATERIAL 2
MEAN	2.493	2.468
STANDARD DEVIATION	0.006	0.006
STANDARD ERROR OF THE MEAN	0.002	0.002

Test 28: Hot Mix Voids in Mineral Aggregate

Method MTC LS-266

Reference Asphalt Institute Manual Series #2

This test involves the calculation of the volume of intergranular void space between the aggregate particles of a compacted paving mixture that includes the air voids and the effective asphalt content, expressed as a percent of the total volume of the sample.

Eighteen laboratories participated but the majority of the participating laboratories reported a VMA that included the absorbed asphalt content. This is not the VMA required under MTC Spec 310 (now M.T.C. 1150). Laboratories G, F, Q & R were the only labs reporting the true VMA, this shows up very clearly in the scatter diagram as they are all clustered down in the lower left quadrant.

The data submitted was rechecked and the true VMA was calculated for those laboratories who provided the aggregate bulk relative densities. The new population now becomes fourteen. The second set of data, averages precision statements, and scatter diagrams shows an improvement. Laboratories K & M however, do not appear to be part of the population. The data was resubmitted deleting labs K & M and the precision limits and scatter diagrams produced.

Examining the precision limits we can see that initially the reporting of erroneous data affected the averages and precision limits. As well, the scatter diagram reveals a high systematic error. The submitting of true values and the removal of labs K & M further increased the precision. Labs K & M should check out their procedures and especially their compaction equipment as their bulk relative density of compacted mix is extremely low (See Test 25).

TEST 20: HOT MIX, VOIDS IN MINERAL AGGREGATE DATA SUBMITTED
TEST PERIOD: 81

TABLE OF TEST RESULTS

	MATERIAL 1		MATERIAL 2	
LAB 1 OPERATOR 1	16.100	16.200	15.600	15.700
LAB 2 OPERATOR 1	16.400	16.400	16.100	16.100
LAB 3 OPERATOR 1	15.600	15.600	15.500	15.700
LAB 4 OPERATOR 1	16.100	16.100	15.800	15.800
LAB 5 OPERATOR 1	15.700	16.000	16.200	15.800
LAB 6 OPERATOR 1	14.200	14.100	13.400	13.100
LAB 7 OPERATOR 1	13.900	14.000	13.400	13.500
LAB 8 OPERATOR 1	15.400	15.400	15.200	15.300
LAB 9 OPERATOR 1	16.100	16.200	16.100	15.900
LAB 10 OPERATOR 1	15.700	16.000	14.900	15.500
LAB 11 OPERATOR 1	17.000	16.500	17.700	20.300
LAB 12 OPERATOR 1	16.070	16.070	16.800	16.800
LAB 13 OPERATOR 1	17.630	17.630	17.730	17.730
LAB 14 OPERATOR 1	16.900	16.200	16.100	15.900
LAB 15 OPERATOR 1	15.600	15.700	15.700	16.400
LAB 16 OPERATOR 1	16.200	16.400	16.300	16.000
LAB 17 OPERATOR 1	14.200	14.100	14.700	14.600
LAB 18 OPERATOR 1	14.300	14.300	14.100	13.900
RANGES	3.730		7.200	

TEST 26: HOT MIX, VOIDS IN MINERAL AGGREGATE **DATA RECALCULATED**
TEST PERIOD: 81

TABLE OF TEST RESULTS

	MATERIAL 1		MATERIAL 2	
PROVINCE				
LAB 1 OPERATOR 1	12.690	12.640	14.300	13.950
LAB 2 OPERATOR 1	13.750	13.650	14.650	14.650
LAB 4 OPERATOR 1	13.430	13.330	13.560	13.430
LAB 5 OPERATOR 1	12.930	12.920	13.010	13.020
LAB 6 OPERATOR 1	14.200	14.100	13.400	13.100
LAB 7 OPERATOR 1	13.900	14.000	13.400	13.500
LAB 11 OPERATOR 1	15.370	15.960	15.740	17.250
LAB 12 OPERATOR 1	14.840	14.840	13.030	13.030
LAB 13 OPERATOR 1	16.300	16.300	14.490	14.490
LAB 14 OPERATOR 1	14.250	13.860	13.660	13.590
LAB 15 OPERATOR 1	13.720	13.830	13.500	13.480
LAB 16 OPERATOR 1	14.110	13.760	14.150	13.970
LAB 17 OPERATOR 1	14.200	14.110	14.540	14.400
LAB 18 OPERATOR 1	14.260	14.270	14.060	13.880
RANGES	3.660		4.240	

TEST 20' HOT MIX, VOIDS IN MINERAL AGGREGATE **LABS K&M OMITTED**
TEST PERIOD' 81

TABLE OF TEST RESULTS

	MATERIAL 1		MATERIAL 2	
PROVINCE				
LAB 1 OPERATOR 1	12.090	12.040	14.000	13.950
LAB 2 OPERATOR 1	13.730	13.650	14.050	14.050
LAB 4 OPERATOR 1	13.490	13.550	13.560	13.480
LAB 5 OPERATOR 1	12.950	12.920	13.010	13.020
LAB 6 OPERATOR 1	14.200	14.100	13.400	13.100
LAB 7 OPERATOR 1	13.900	14.000	13.400	13.500
LAB 12 OPERATOR 1	14.040	14.840	13.030	13.050
LAB 14 OPERATOR 1	14.490	13.800	13.600	13.590
LAB 15 OPERATOR 1	13.720	13.830	13.500	13.480
LAB 16 OPERATOR 1	14.110	13.700	14.150	13.970
LAB 17 OPERATOR 1	14.200	14.110	14.340	14.400
LAB 18 OPERATOR 1	14.260	14.270	14.060	13.860
RANGES	2.200		1.640	

TEST 26: HOT MIX, VOIDS IN MINERAL AGGREGATE DATA SUBMITTED
TEST PERIOD: 81

WITHIN-LABORATORY AVERAGES AND STANDARD DEVIATIONS

LAB	AVERAGE	SIGMA
MATERIAL 1		
LAB 1	16.150	0.068
LAB 2	16.400	0.011
LAB 3	15.700	0.142
LAB 4	16.100	0.019
LAB 5	15.850	0.213
LAB 6	14.150	0.073
LAB 7	13.950	0.073
LAB 8	15.400	0.019
LAB 9	16.150	0.068
LAB 10	15.650	0.213
LAB 11	16.750	0.354
LAB 12	16.070	0.000
LAB 13	17.630	0.016
LAB 14	16.550	0.495
LAB 15	15.650	0.073
LAB 16	16.300	0.141
LAB 17	14.150	0.073
LAB 18	14.300	0.015
MATERIAL 2		
LAB 1	15.650	0.073
LAB 2	16.100	0.019
LAB 3	15.600	0.142
LAB 4	15.800	0.017
LAB 5	16.000	0.283
LAB 6	13.250	0.213
LAB 7	13.450	0.072
LAB 8	15.250	0.074
LAB 9	16.000	0.141
LAB 10	15.200	0.425
LAB 11	19.000	1.838
LAB 12	16.800	0.011
LAB 13	17.730	0.019
LAB 14	16.000	0.141
LAB 15	16.050	0.495
LAB 16	16.150	0.212
LAB 17	14.650	0.073
LAB 18	14.000	0.143

TEST 28: HOT MIX, VOIDS IN MINERAL AGGREGATE **DATA RECALCULATED**
TEST PERIOD: 81

WITHIN-LABORATORY AVERAGES AND STANDARD DEVIATIONS

LAB	AVERAGE	SIGMA
MATERIAL 1		
LAB 1	12.665	0.040
LAB 2	13.690	0.059
LAB 4	13.380	0.072
LAB 5	12.925	0.017
LAB 6	14.150	0.073
LAB 7	13.950	0.073
LAB 11	13.665	0.418
LAB 12	14.040	0.035
LAB 13	16.300	0.028
LAB 14	14.055	0.277
LAB 15	13.775	0.080
LAB 16	13.935	0.240
LAB 17	14.155	0.065
LAB 18	14.265	0.010
MATERIAL 2		
LAB 1	13.975	0.038
LAB 2	14.650	0.018
LAB 4	13.495	0.093
LAB 5	13.015	0.008
LAB 6	13.250	0.213
LAB 7	13.450	0.072
LAB 11	16.495	1.068
LAB 12	13.030	0.011
LAB 13	14.490	0.011
LAB 14	13.625	0.054
LAB 15	13.490	0.017
LAB 16	14.060	0.128
LAB 17	14.470	0.101
LAB 18	13.970	0.129

TEST 23' HOT MIX, VOIDS IN MINERAL AGGREGATE **LABS K&M OMITTED**
TEST PERIOD' 81

WITHIN-LABORATORY AVERAGES AND STANDARD DEVIATIONS

LAB	AVERAGE	SIGMA
MATERIAL 1		
LAB 1	12.665	0.040
LAB 2	13.690	0.059
LAB 4	13.360	0.072
LAB 5	12.925	0.017
LAB 6	14.150	0.075
LAB 7	13.950	0.073
LAB 12	14.040	0.015
LAB 14	14.055	0.277
LAB 15	13.775	0.080
LAB 16	13.955	0.240
LAB 17	14.155	0.065
LAB 18	14.265	0.010
MATERIAL 2		
LAB 1	13.975	0.038
LAB 2	14.650	0.018
LAB 4	13.495	0.093
LAB 5	13.015	0.008
LAB 6	13.250	0.213
LAB 7	13.450	0.072
LAB 12	13.030	0.013
LAB 14	13.625	0.054
LAB 15	13.490	0.017
LAB 16	14.060	0.128
LAB 17	14.470	0.101
LAB 18	13.970	0.149

TEST 28: HOT MIX VOIDS IN MINERAL AGGREGATE

TYPE OF PRECISION	MEAN TEST VALUES		
	Correlation 15.70	15.73	ASTM
Single Laboratory 95% Difference Limit	1.35	0.49	not available
Multi Laboratory 95% Difference Limit	4.30	2.60	not available

Table Precision over a range of values.
DATA SUBMITTED

TEST 28

TYPE OF PRECISION	MEAN TEST VALUES		
	Correlation 13.96	14.13	ASTM
Single Laboratory 95% Difference Limit	0.85	0.44	not available
Multi Laboratory 95% Difference Limit	3.19	2.65	not available

Table Precision over a range of values.
DATA RECALCULATED

TEST 28: HOT MIX VOIDS IN MINERAL AGGREGATE

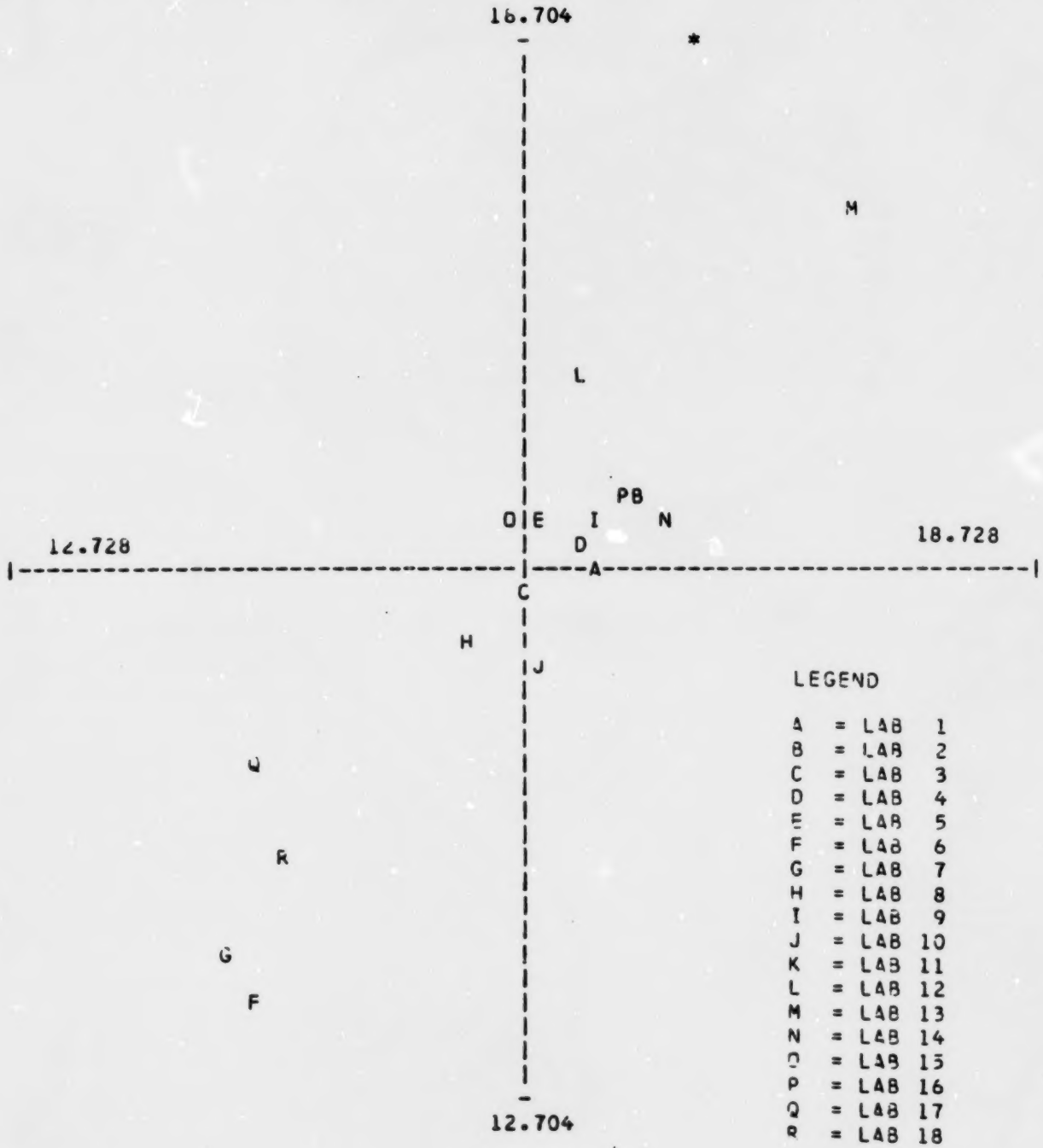
TYPE OF PRECISION	MEAN TEST VALUES		
	Correlation 13.707	13.815	ASTM
Single Laboratory 95% Difference Limit	0.27	0.34	not available
Multi Laboratory 95% Difference Limit	1.51	1.56	not available

Table Precision over a range of values.
WITH LABS K & M OMITTED

TEST 26: HOT MIX, VOIDS IN MINERAL AGGREGATE DATA SUBMITTED
TEST PERIOD: 81

SCATTER PLOT ANALYSIS
SCALE: 0.333 UNITS=1 CM

HORIZONTAL AXIS: MATERIAL 1
VERTICAL AXIS: MATERIAL 2



LEGEND

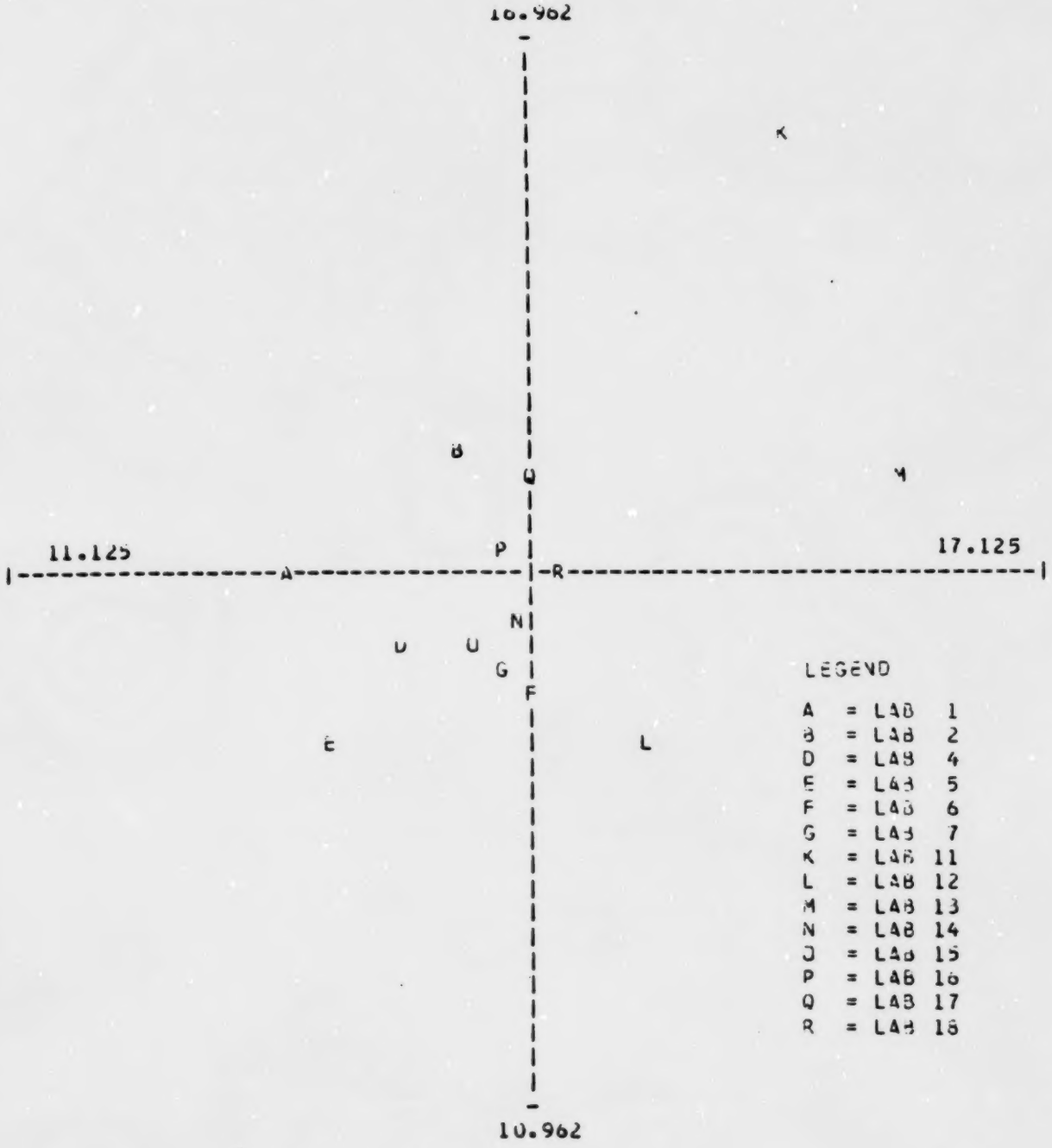
A	=	LAB 1
B	=	LAB 2
C	=	LAB 3
D	=	LAB 4
E	=	LAB 5
F	=	LAB 6
G	=	LAB 7
H	=	LAB 8
I	=	LAB 9
J	=	LAB 10
K	=	LAB 11
L	=	LAB 12
M	=	LAB 13
N	=	LAB 14
O	=	LAB 15
P	=	LAB 16
Q	=	LAB 17
R	=	LAB 18

	MATERIAL 1	MATERIAL 2
MEAN	15.728	15.704
STANDARD DEVIATION	0.995	1.405
STANDARD ERROR OF THE MEAN	0.166	0.234

TEST 26: HOT MIX, VOIDS IN MINERAL AGGREGATE DATA RECALCULATED
TEST PERIOD: 01

SCATTER PLOT ANALYSIS
SCALE: 0.333 UNITS=1 CM

HORIZONTAL AXIS: MATERIAL 1
VERTICAL AXIS: MATERIAL 2



LEGEND

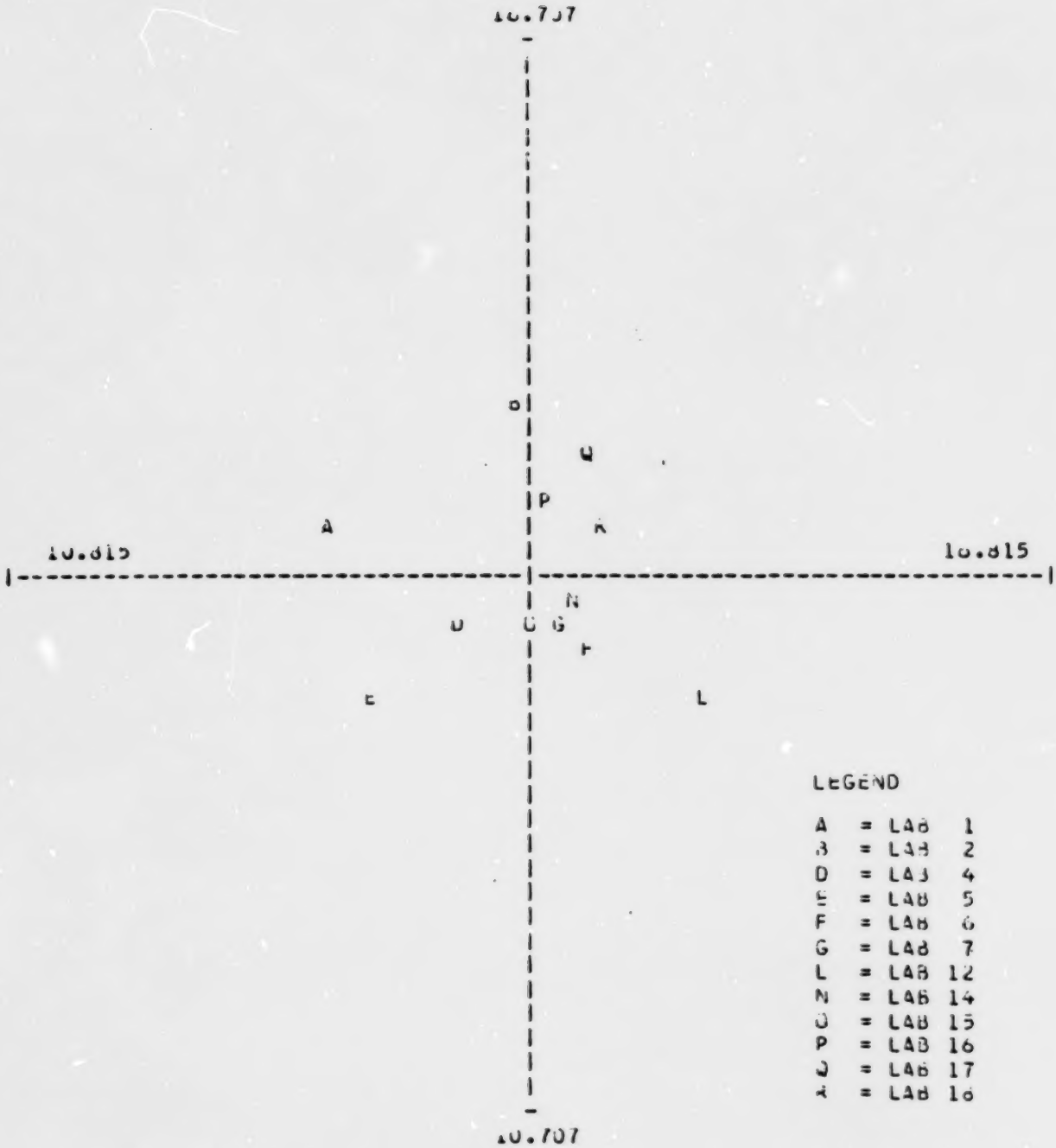
A	= LAB	1
B	= LAB	2
D	= LAB	4
E	= LAB	5
F	= LAB	6
G	= LAB	7
K	= LAB	11
L	= LAB	12
M	= LAB	13
N	= LAB	14
O	= LAB	15
P	= LAB	16
Q	= LAB	17
R	= LAB	18

	MATERIAL 1	MATERIAL 2
MEAN	14.125	13.962
STANDARD DEVIATION	0.955	0.909
STANDARD ERROR OF THE MEAN	0.181	0.172

TEST 20: HOT MIX, VOIDS IN MINERAL AGGREGATE **LABS K&M OMITTED**
TEST PERIOD: 01

SCATTER PLOT ANALYSIS
SCALE: 0.333 UNITS= 1 CM

HORIZONTAL AXIS: MATERIAL 1
VERTICAL AXIS: MATERIAL 2



LEGEND

A	= LAB	1
B	= LAB	2
D	= LAB	4
E	= LAB	5
F	= LAB	6
G	= LAB	7
L	= LAB	12
N	= LAB	14
O	= LAB	15
P	= LAB	16
Q	= LAB	17
R	= LAB	18

	MATERIAL 1	MATERIAL 2
MEAN	13.615	13.707
STANDARD DEVIATION	0.588	0.519
STANDARD ERROR OF THE MEAN	0.120	0.106

Test 29: Hot Mix, % Air Voids in Sample

Method MTC LS-265

Reference ASTM D3203-75

This test involves the calculation of the volume of air voids in a compacted Marshall briquette.

Eighteen laboratories were involved in calculating this test, duplicated figures for labs 2, 12 and 13 were used because of reasons discussed earlier. The effect of low bulk densities by labs 11 and 13 also shows up in this test.

The precision limits as calculated for the eighteen laboratories should not be used. The precision limits for MTC ONLY are presented for comparison purposes. It is hoped that in the future MTC and outside laboratories will show less spread than they are now. When that happens then precision limits from the larger population will become more meaningful.

TEST 29: HOT MIX, % AIR VOIDS IN SAMPLE
TEST PERIOD: 81

TABLE OF TEST RESULTS

	MATERIAL 1		MATERIAL 2	
LAB 1 OPERATOR 1	3.700	3.600	3.100	3.100
LAB 2 OPERATOR 1	4.100	4.100	3.600	3.600
LAB 3 OPERATOR 1	3.300	3.400	3.000	3.200
LAB 4 OPERATOR 1	3.700	3.700	3.300	3.300
LAB 5 OPERATOR 1	3.300	3.600	3.600	3.200
LAB 6 OPERATOR 1	4.500	4.400	3.300	2.900
LAB 7 OPERATOR 1	4.000	4.000	3.100	3.300
LAB 8 OPERATOR 1	2.900	3.000	2.700	2.800
LAB 9 OPERATOR 1	3.700	3.900	3.600	3.400
LAB 10 OPERATOR 1	3.400	3.600	2.700	3.000
LAB 11 OPERATOR 1	4.700	4.400	5.300	8.300
LAB 12 OPERATOR 1	4.150	4.150	4.640	4.640
LAB 13 OPERATOR 1	5.730	5.730	5.800	5.800
LAB 14 OPERATOR 1	4.800	4.200	3.700	3.300
LAB 15 OPERATOR 1	3.300	3.400	3.200	4.000
LAB 16 OPERATOR 1	4.000	4.200	3.900	3.600
LAB 17 OPERATOR 1	5.000	4.700	5.000	4.900
LAB 18 OPERATOR 1	5.000	4.900	4.700	4.200
RANGES	2.830		5.600	

TEST 29: HOT MIX, % AIR VOIDS IN SAMPLE
TEST PERIOD: 81

WITHIN-LABORATORY AVERAGES AND STANDARD DEVIATIONS

LAB	AVERAGE	SIGMA
MATERIAL 1		
LAB 1	3.750	0.071
LAB 2	4.100	0.005
LAB 3	3.350	0.071
LAB 4	3.700	0.002
LAB 5	3.450	0.212
LAB 6	4.450	0.071
LAB 7	4.000	0.000
LAB 8	2.950	0.071
LAB 9	3.800	0.141
LAB 10	3.500	0.141
LAB 11	4.550	0.212
LAB 12	4.150	0.004
LAB 13	5.730	0.004
LAB 14	4.500	0.424
LAB 15	3.350	0.071
LAB 16	4.100	0.141
LAB 17	4.850	0.212
LAB 18	4.950	0.071
MATERIAL 2		
LAB 1	3.100	0.002
LAB 2	3.000	0.000
LAB 3	3.100	0.141
LAB 4	3.300	0.002
LAB 5	3.400	0.283
LAB 6	3.100	0.283
LAB 7	3.200	0.141
LAB 8	2.750	0.071
LAB 9	3.500	0.141
LAB 10	2.850	0.212
LAB 11	6.800	2.121
LAB 12	4.640	0.003
LAB 13	5.800	0.003
LAB 14	3.500	0.283
LAB 15	3.600	0.566
LAB 16	3.750	0.212
LAB 17	4.950	0.071
LAB 18	4.450	0.354

TEST 29: HOT MIX, % AIR VOIDS IN SAMPLE

TYPE OF PRECISION	MEAN TEST VALUES		
	Correlation 3.9	4.1	ASTM
Single Laboratory 95% Difference Limit	1.5	0.4	not available
Multi Laboratory 95% Difference Limit	3.4	2.0	not available

Table Precision over a range of values.
ALL LABORATORIES

TEST 29

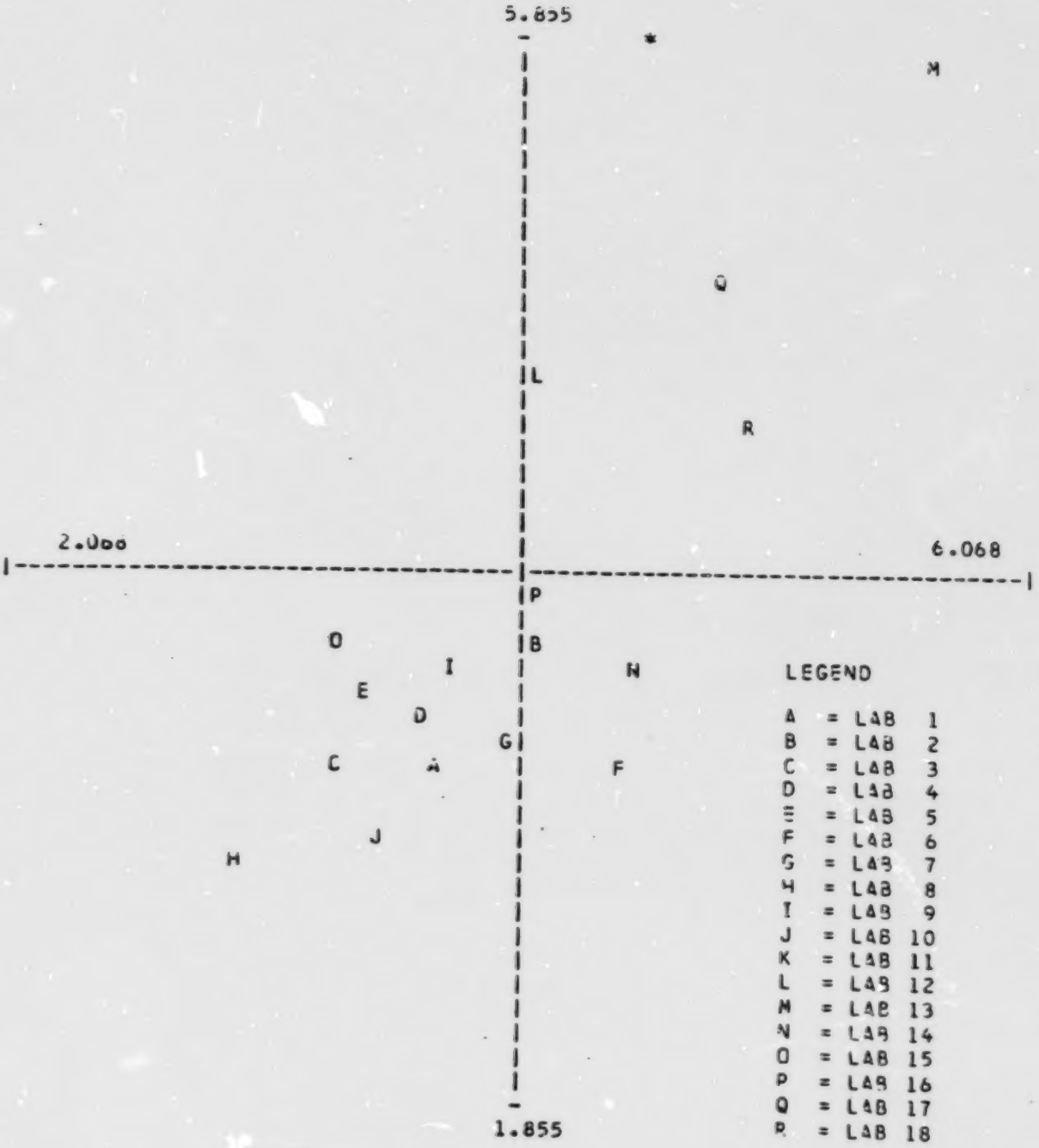
TYPE OF PRECISION	MEAN TEST VALUES		
	Correlation 3.2	3.7	ASTM
Single Laboratory 95% Difference Limit	0.5	0.3	not available
Multi Laboratory 95% Difference Limit	0.8	1.1	not available

Table Precision over a range of values.
MTC LABS ONLY

TEST 29: HOT MIX, % AIR VOIDS IN SAMPLE
TEST PERIOD: 81

SCATTER PLOT ANALYSIS
SCALE: 0.222 UNITS=1 CM

HORIZONTAL AXIS: MATERIAL 1
VERTICAL AXIS: MATERIAL 2

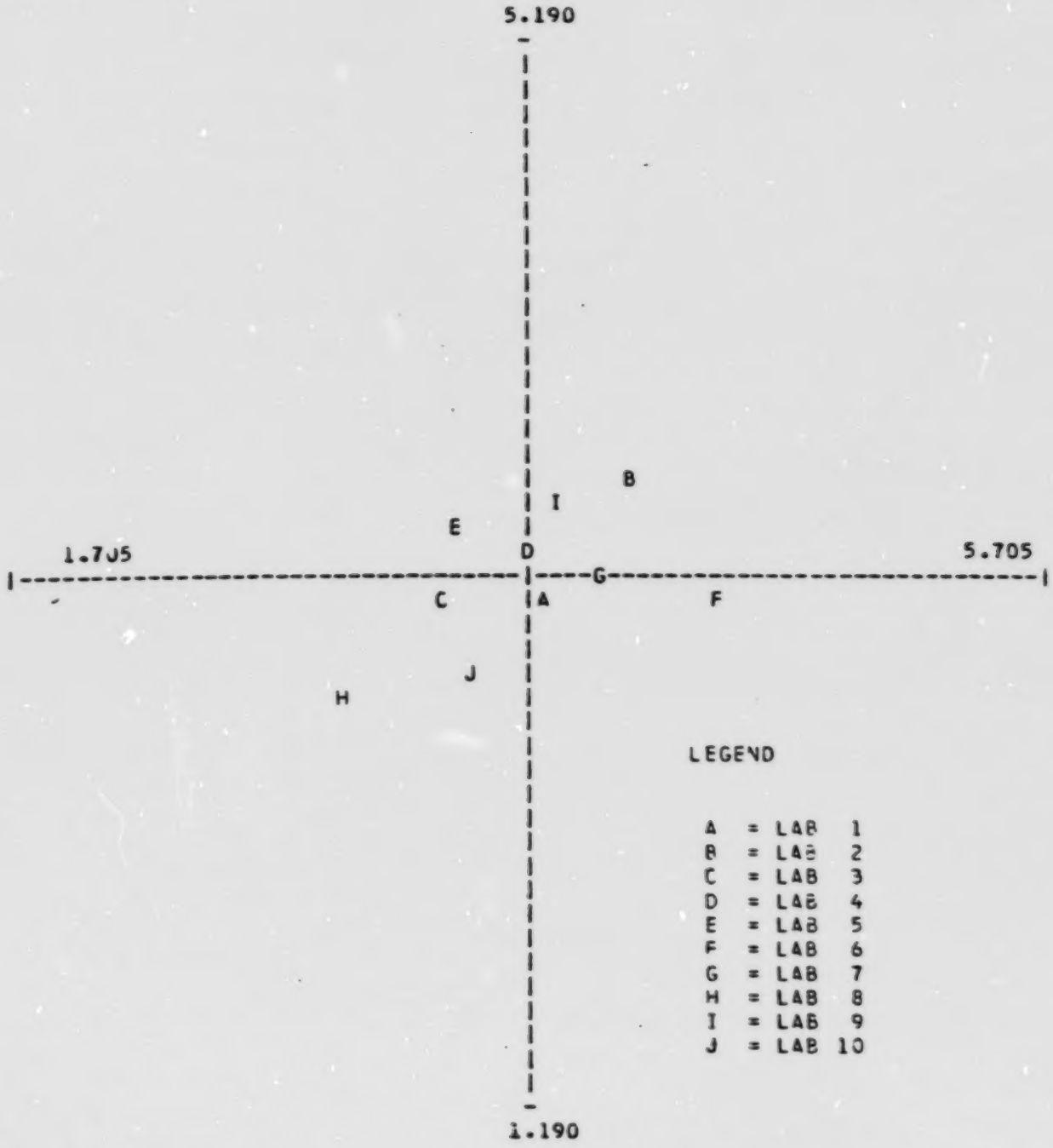


	MATERIAL 1	MATERIAL 2
MEAN	4.068	3.855
STANDARD DEVIATION	0.686	1.136
STANDARD ERROR OF THE MEAN	0.114	0.189

TEST 29: HOT MIX, % AIR VOIDS IN SAMPLE MTC LABS ONLY
TEST PERIOD: 81

SCATTER PLOT ANALYSIS
SCALE: 0.222 UNITS=1 CM

HORIZONTAL AXIS: MATERIAL 1
VERTICAL AXIS: MATERIAL 2



LEGEND

A	= LAB	1
B	= LAB	2
C	= LAB	3
D	= LAB	4
E	= LAB	5
F	= LAB	6
G	= LAB	7
H	= LAB	8
I	= LAB	9
J	= LAB	10

	MATERIAL 1	MATERIAL 2
MEAN	3.705	3.190
STANDARD DEVIATION	0.419	0.288
STANDARD ERROR OF THE MEAN	0.094	0.064

Test 30: Surface Dry Air Voids in Sample

This test involves the calculation of air voids in a compacted bituminous mix using the surface dry maximum density.

Twelve laboratories were able to perform this test.

Examining the scatter diagram one finds that the MTC Labs fall mainly in the lower left quadrant and only lab 'N' appears to be part of the same population. Again these results are affected by the B.R.D. results (Test 25) and any laboratories that had trouble with it will be "off the mark" on this test as well.

TEST 30: HOT MIX, % AIR VOIDS IN SAMPLE (SD)
TEST PERIOD: 81

TABLE OF TEST RESULTS

	MATERIAL 1		MATERIAL 2	
LAB 1 OPERATOR 1	2.800	2.900	2.300	2.300
LAB 2 OPERATOR 1	3.100	3.100	2.800	2.600
LAB 4 OPERATOR 1	2.900	2.800	2.200	2.300
LAB 6 OPERATOR 1	3.500	3.400	2.100	1.800
LAB 7 OPERATOR 1	2.800	2.700	1.900	2.100
LAB 10 OPERATOR 1	2.800	2.300	2.000	2.200
LAB 12 OPERATOR 1	3.260	3.260	3.530	3.530
LAB 13 OPERATOR 1	4.770	4.770	3.830	3.830
LAB 14 OPERATOR 1	3.400	2.400	2.200	1.900
LAB 15 OPERATOR 1	2.600	2.500	2.700	3.400
LAB 17 OPERATOR 1	3.500	3.200	3.600	3.500
LAB 18 OPERATOR 1	3.300	3.800	2.800	3.000
RANGES	2.470		2.030	

TEST 30: HOT MIX, % AIR VOIDS IN SAMPLE (SD)
TEST PERIOD: 01

WITHIN-LABORATORY AVERAGES AND STANDARD DEVIATIONS

LAB	AVERAGE	SIGMA
MATERIAL 1		
LAB 1	2.850	0.071
LAB 2	3.400	0.002
LAB 4	2.850	0.071
LAB 6	3.450	0.071
LAB 7	2.750	0.071
LAB 10	2.550	0.354
LAB 12	3.260	0.001
LAB 13	4.770	0.004
LAB 14	2.900	0.707
LAB 15	2.550	0.071
LAB 17	3.350	0.212
LAB 18	3.550	0.354
MATERIAL 2		
LAB 1	2.300	0.002
LAB 2	2.800	0.002
LAB 4	2.250	0.071
LAB 6	1.950	0.212
LAB 7	2.000	0.141
LAB 10	2.100	0.141
LAB 12	3.530	0.002
LAB 13	3.830	0.002
LAB 14	2.050	0.212
LAB 15	3.050	0.495
LAB 17	3.550	0.071
LAB 18	2.900	0.141

TEST 30: HOT MIX AIR VOIDS IN SAMPLE (S.D.)

TYPE OF PRECISION	MEAN TEST VALUES		
	Correlation 2.7	3.2	ASTM
Single Laboratory 95% Difference Limit	0.5	0.7	not available
Multi Laboratory 95% Difference Limit	1.7	2.0	not available

Table Precision over a range of values.
ALL LABORATORIES

TEST 30

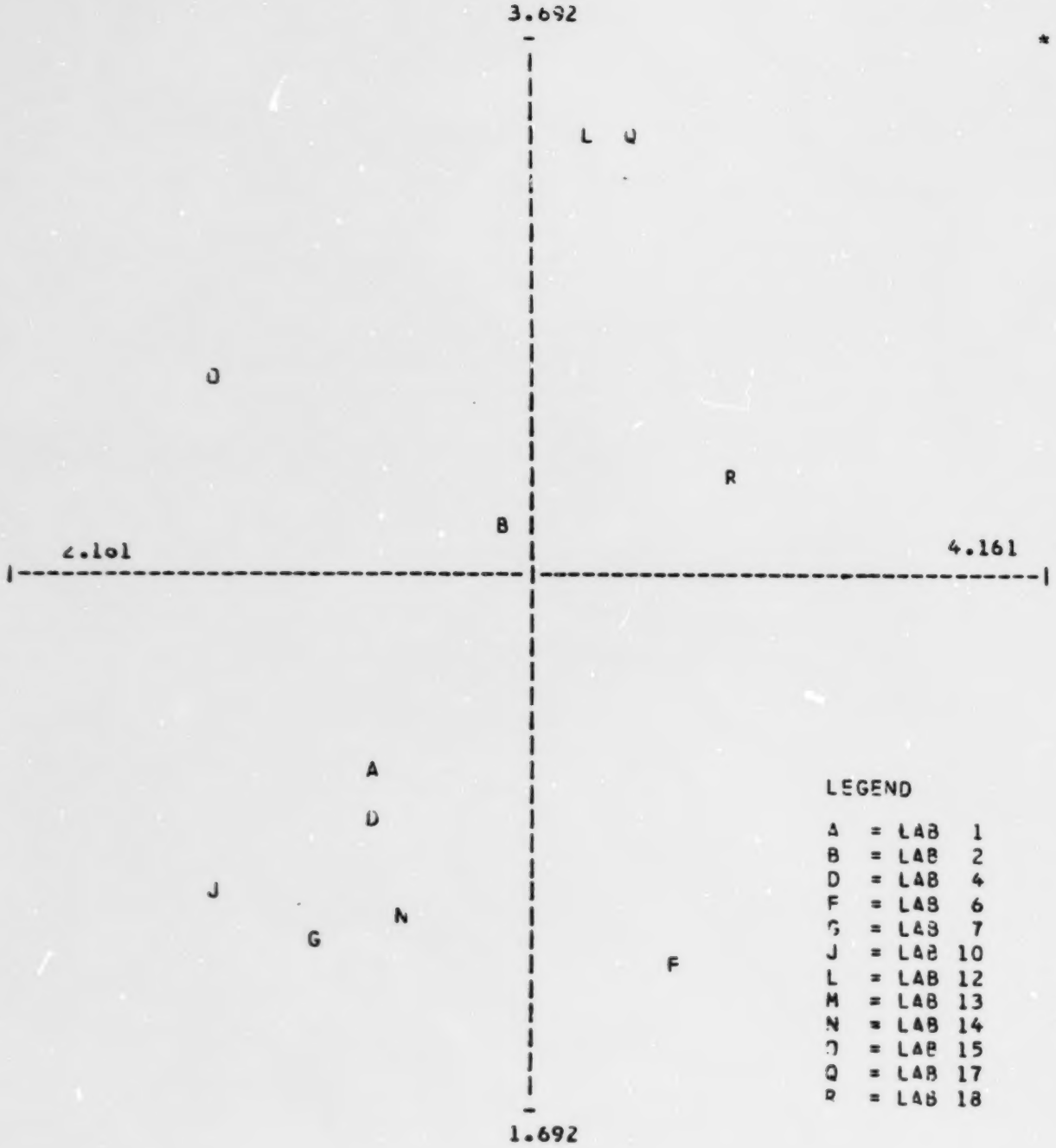
TYPE OF PRECISION	MEAN TEST VALUES		
	Correlation 2.2	2.9	ASTM
Single Laboratory 95% Difference Limit	0.4	0.4	not available
Multi Laboratory 95% Difference Limit	0.9	0.8	not available

Table Precision over a range of values.
MTC LABS ONLY

TEST 30: HOT MIX, % AIR VOIDS IN SAMPLE (SD)
TEST PERIOD: 81

SCATTER PLOT ANALYSIS
SCALE: 0.111 UNITS=1 CM

HORIZONTAL AXIS: MATERIAL 1
VERTICAL AXIS: MATERIAL 2



LEGEND

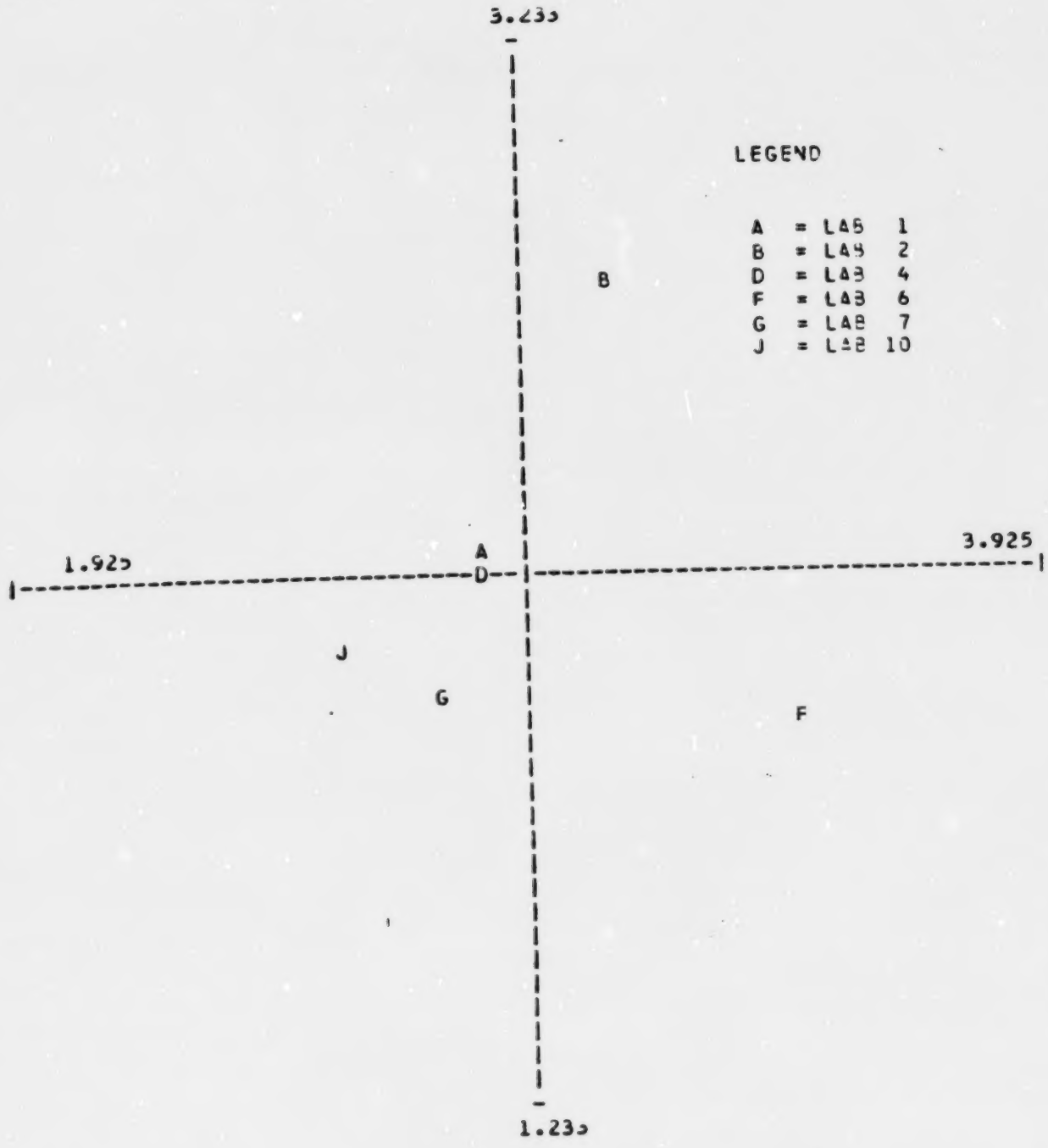
A	=	LAB 1
B	=	LAB 2
D	=	LAB 4
F	=	LAB 6
G	=	LAB 7
J	=	LAB 10
L	=	LAB 12
M	=	LAB 13
N	=	LAB 14
O	=	LAB 15
Q	=	LAB 17
R	=	LAB 18

	MATERIAL 1	MATERIAL 2
MEAN	3.161	2.692
STANDARD DEVIATION	0.623	0.676
STANDARD ERROR OF THE MEAN	0.127	0.138

TEST 30: HOT MIX, % AIR VOIDS IN SAMPLE (SD) MTC LABS ONLY
TEST PERIOD: 61

SCATTER PLOT ANALYSIS
SCALE: 0.111 UNITS=1 CM

HORIZONTAL AXIS: MATERIAL
VERTICAL AXIS: MATERIAL



	MATERIAL 1	MATERIAL 2
MEAN	2.925	2.233
STANDARD DEVIATION	0.319	0.308
STANDARD ERROR OF THE MEAN	0.092	0.089

Test 31: Hot Mix, Marshall Stability

Method MTC LS-263

Reference ASTM D1559-76

This test measures the resistance to plastic flow of cylindrical specimens loaded diametrically in a test head. The Marshall stability is the maximum resistance that the specimen gives at 60°C (140°F) when loaded at a uniform rate.

Eighteen laboratories took part in this test. A view of the scatter diagram produced with all laboratories and that for MTC ONLY show a systematic error. A laboratory finding a low or high stability on one material will show the same for the other material.

The precision limits of both the ALL LABORATORY and MTC ONLY indicate that the test is fairly imprecise or that there are differences in equipment that produce a high systematic error. The fact that the bulk relative densities have a wide spread will also effect this test. A briquette with a high bulk density, representing a more thorough compacted mix, should yield higher stability.

If the laboratories performing the Marshall tests are able to come closer together on bulk relative densities this should also tighten the range of stability results. All future participants should also check that their breaking head conforms to the drawing 3-4 in MTC LS-263 and Figure 3, ASTM D1559. There are some Marshall Test Heads (Original Marshall) which do not conform to these drawings and will yield lower stabilities. Laboratories should also check for excessive wear of the test head which will also decrease stabilities.

TEST 31: HOT MIX, MARSHALL STABILITY, NEWTONS
TEST PERIOD: 81

TABLE OF TEST RESULTS

	MATERIAL 1		MATERIAL 2	
LAB 1				
OPERATOR 1	12407.00	12525.00	13004.00	13648.00
LAB 2				
OPERATOR 1	11342.00	11342.00	12490.00	12490.00
LAB 3				
OPERATOR 1	11755.00	10712.00	10245.00	10036.00
LAB 4				
OPERATOR 1	13420.00	13974.00	13569.00	14416.00
LAB 5				
OPERATOR 1	14070.00	14732.00	13088.00	13961.00
LAB 6				
OPERATOR 1	13259.00	12085.00	14223.00	12549.00
LAB 7				
OPERATOR 1	13246.00	12610.00	14321.00	14346.00
LAB 8				
OPERATOR 1	11154.00	10824.00	11893.00	11417.00
LAB 9				
OPERATOR 1	13499.00	13031.00	13250.00	12905.00
LAB 10				
OPERATOR 1	13143.00	13099.00	13967.00	12365.00
LAB 11				
OPERATOR 1	14604.00	12343.00	14056.00	12404.00
LAB 12				
OPERATOR 1	11903.00	11965.00	12454.00	12454.00
LAB 13				
OPERATOR 1	10879.00	10879.00	9748.00	9748.00
LAB 14				
OPERATOR 1	8651.00	9690.00	10896.00	10623.00
LAB 15				
OPERATOR 1	13700.00	14197.00	14627.00	15731.00
LAB 16				
OPERATOR 1	11221.00	11167.00	10704.00	12075.00
LAB 17				
OPERATOR 1	12060.00	12617.00	9210.00	9805.00
LAB 18				
OPERATOR 1	8525.00	8613.00	8614.00	6823.00
RANGES	6207.000		7117.000	

TEST 31: HOT MIX, MARSHALL STABILITY, NEWTONS
TEST PERIOD: 81

WITHIN-LABORATORY AVERAGES AND STANDARD DEVIATIONS

LAB	AVERAGE	SIGMA
MATERIAL 1		
LAB 1	12396.000	100.479
LAB 2	12342.000	0.000
LAB 3	11233.500	737.552
LAB 4	13701.000	386.140
LAB 5	14704.000	39.598
LAB 6	12672.000	830.132
LAB 7	12928.000	449.711
LAB 8	10989.000	233.512
LAB 9	13265.000	331.010
LAB 10	13121.000	30.984
LAB 11	13473.500	1598.789
LAB 12	11965.000	0.000
LAB 13	10879.000	0.000
LAB 14	9170.500	734.705
LAB 15	13948.500	351.454
LAB 16	11204.000	24.331
LAB 17	12338.500	393.995
LAB 18	8569.000	62.865
MATERIAL 2		
LAB 1	13756.000	130.231
LAB 2	12490.000	0.000
LAB 3	10150.500	133.666
LAB 4	13992.500	598.986
LAB 5	14524.500	796.924
LAB 6	13286.000	1325.141
LAB 7	14533.500	17.889
LAB 8	11055.000	336.713
LAB 9	11577.500	1877.390
LAB 10	13166.000	1132.784
LAB 11	13230.000	1168.144
LAB 12	12454.000	0.000
LAB 13	9748.000	5.657
LAB 14	10759.500	193.329
LAB 15	15179.000	780.707
LAB 16	11389.500	969.445
LAB 17	9507.500	420.818
LAB 18	6718.500	147.892

TEST 31: HOT MIX MARSHALL STABILITY

TYPE OF PRECISION	MEAN TEST VALUES		
	Correlation 12,105	12,215	ASTM
Single Laboratory 95% Difference Limit	1,510	2,195	not available
Multi Laboratory 95% Difference Limit	4,630	5,235	not available

Table Precision over a range of values.
ALL LABORATORIES

TEST 31

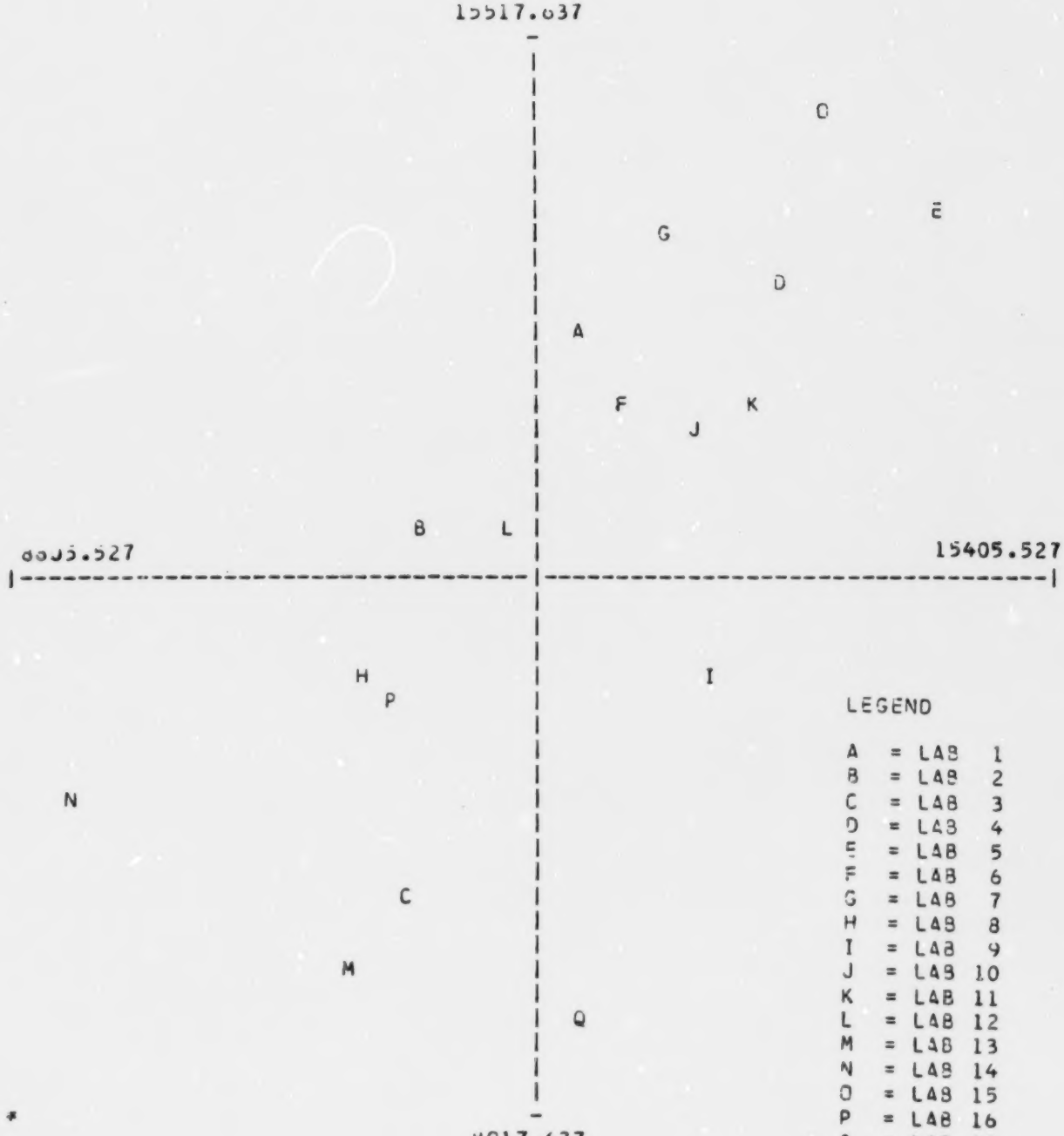
TYPE OF PRECISION	MEAN TEST VALUES		
	Correlation 12,635	12,893	ASTM
Single Laboratory 95% Difference Limit	1,190	2,480	not available
Multi Laboratory 95% Difference Limit	3,330	4,101	not available

Table Precision over a range of values.
MTC LABS ONLY

TEST 31: HOT MIX, MARSHALL STABILITY, NEWTONS
TEST PERIOD: 81

SCATTER PLOT ANALYSIS
SCALE: 303.975 UNITS=1 CM

HORIZONTAL AXIS: MATERIAL 1
VERTICAL AXIS: MATERIAL 2



LEGEND

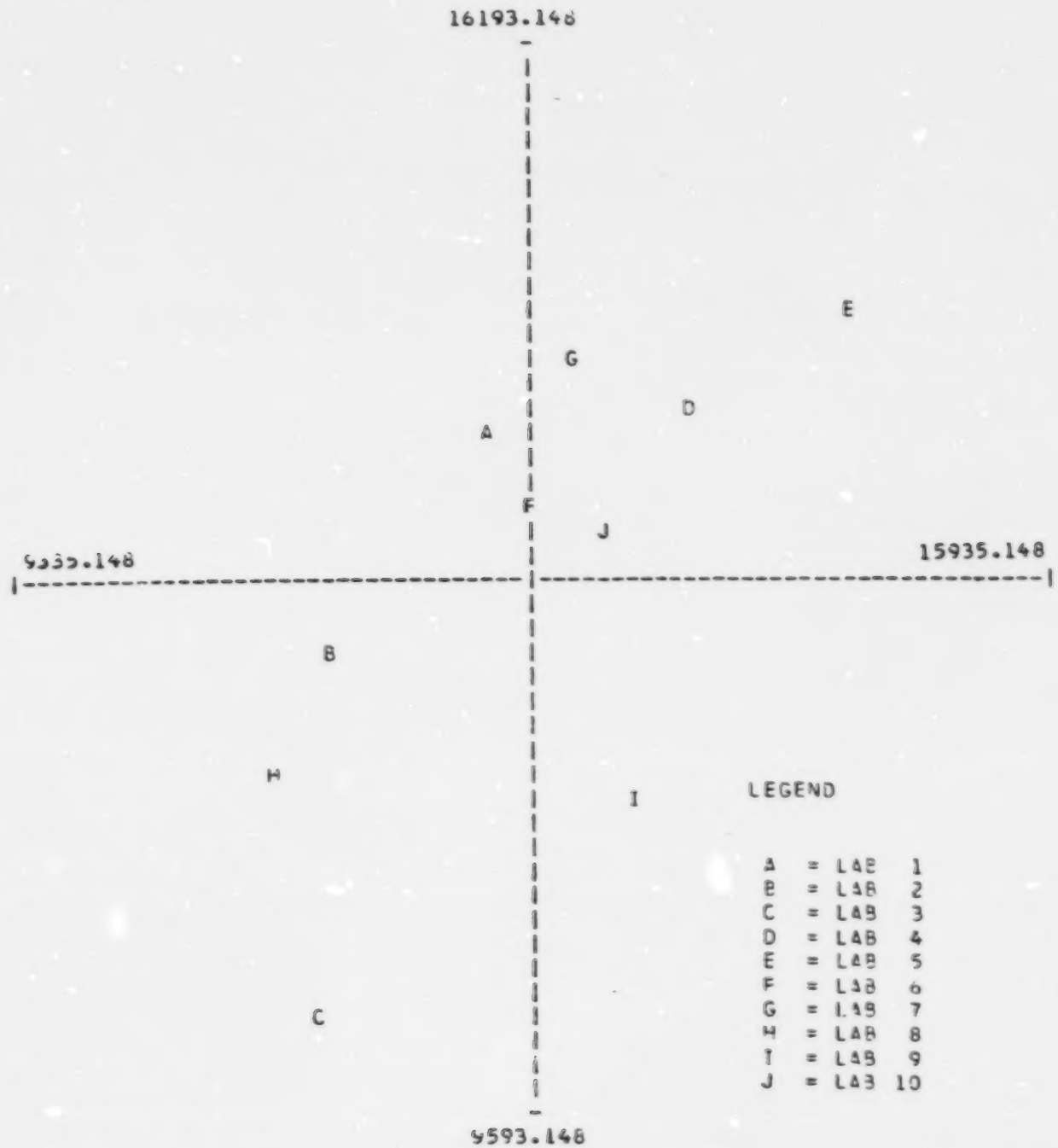
A	=	LAB 1
B	=	LAB 2
C	=	LAB 3
D	=	LAB 4
E	=	LAB 5
F	=	LAB 6
G	=	LAB 7
H	=	LAB 8
I	=	LAB 9
J	=	LAB 10
K	=	LAB 11
L	=	LAB 12
M	=	LAB 13
N	=	LAB 14
O	=	LAB 15
P	=	LAB 16
Q	=	LAB 17
R	=	LAB 18

	MATERIAL 1	MATERIAL 2
MEAN	12105.527	12217.637
STANDARD DEVIATION	1633.423	1944.981
STANDARD ERROR OF THE MEAN	272.237	324.163

TEST 31: HOT MIX, MARSHALL STABILITY, NEWTONS MTC LABS ONLY
TEST PERIOD: 81

SCATTER PLOT ANALYSIS
SCALE: 500.975 UNITS=1 CM

HORIZONTAL AXIS: MATERIAL 1
VERTICAL AXIS: MATERIAL 2



	MATERIAL 1	MATERIAL 2
MEAN	12635.148	12893.148
STANDARD DEVIATION	1100.549	1512.035
STANDARD ERROR OF THE MEAN	200.708	338.101

Test 32: Hot Mix, Marshall Flow

Method MTC LS-263

Reference ASTM D1559-76

This test measures the plastic flow of a bituminous mixture at 60°C (140°F) and is the deformation in 0.25 mm units (0.01 inches) of the briquette at maximum resistance (i.e. just as the load drops off).

Eighteen laboratories reported test results. The pattern in the scatter diagram again reflects systematic error in the test. Reasons are the same as for Test 31: Marshall Stability.

TEST 32: HOT MIX, MARSHALL FLOW, 0.025MM UNITS
TEST PERIOD: 81

TABLE OF TEST RESULTS

	MATERIAL 1		MATERIAL 2	
LAB 1 OPERATOR 1	9.800	10.100	11.300	11.400
LAB 2 OPERATOR 1	10.300	10.300	11.400	11.400
LAB 3 OPERATOR 1	11.000	9.500	10.500	10.600
LAB 4 OPERATOR 1	9.700	9.400	9.600	9.900
LAB 5 OPERATOR 1	12.700	12.600	13.500	13.300
LAB 6 OPERATOR 1	8.900	8.600	10.500	10.200
LAB 7 OPERATOR 1	9.500	8.200	11.200	10.800
LAB 8 OPERATOR 1	13.000	12.600	13.400	12.600
LAB 9 OPERATOR 1	12.100	11.200	10.600	12.200
LAB 10 OPERATOR 1	9.500	9.000	10.400	10.300
LAB 11 OPERATOR 1	9.100	8.100	7.800	7.400
LAB 12 OPERATOR 1	4.700	4.700	6.300	6.300
LAB 13 OPERATOR 1	9.300	9.300	10.000	10.000
LAB 14 OPERATOR 1	10.400	12.100	11.700	12.200
LAB 15 OPERATOR 1	9.400	8.900	10.700	11.300
LAB 16 OPERATOR 1	7.500	9.000	9.300	10.200
LAB 17 OPERATOR 1	8.400	7.700	8.200	8.900
LAB 18 OPERATOR 1	7.000	7.100	7.500	8.400
RANGES	8.500		7.200	

TEST 32: HOT MIX, MARSHALL FLOW, 0.025MM UNITS
TEST PERIOD: 01

WITHIN-LABORATORY AVERAGES AND STANDARD DEVIATIONS

LAB	AVERAGE	SIGMA
MATERIAL 1		
LAB 1	9.950	0.213
LAB 2	10.300	0.212
LAB 3	10.250	1.061
LAB 4	9.550	0.213
LAB 5	12.050	0.073
LAB 6	8.750	0.213
LAB 7	8.050	0.919
LAB 8	12.800	0.283
LAB 9	11.050	0.637
LAB 10	9.250	0.354
LAB 11	8.000	0.707
LAB 12	4.700	0.000
LAB 13	9.300	0.035
LAB 14	11.250	1.202
LAB 15	9.150	0.354
LAB 16	8.150	1.202
LAB 17	8.050	0.495
LAB 18	7.050	0.071
MATERIAL 2		
LAB 1	11.350	0.071
LAB 2	11.400	0.017
LAB 3	10.550	0.072
LAB 4	9.750	0.213
LAB 5	13.400	0.143
LAB 6	10.350	0.212
LAB 7	11.300	0.283
LAB 8	13.000	0.566
LAB 9	11.400	1.131
LAB 10	10.350	0.071
LAB 11	7.600	0.283
LAB 12	6.300	0.000
LAB 13	10.000	0.000
LAB 14	11.950	0.354
LAB 15	11.000	0.425
LAB 16	9.750	0.637
LAB 17	8.550	0.495
LAB 18	7.950	0.636

TEST 32: HOT MIX MARSHALL FLOW

TYPE OF PRECISION	MEAN TEST VALUES		
	Correlation 9.5	10.3	ASTM
Single Laboratory 95% Difference Limit	1.7	1.2	not available
Multi Laboratory 95% Difference Limit	5.5	5.1	not available

Table Precision over a range of values.
ALL LABORATORIES

TEST 32

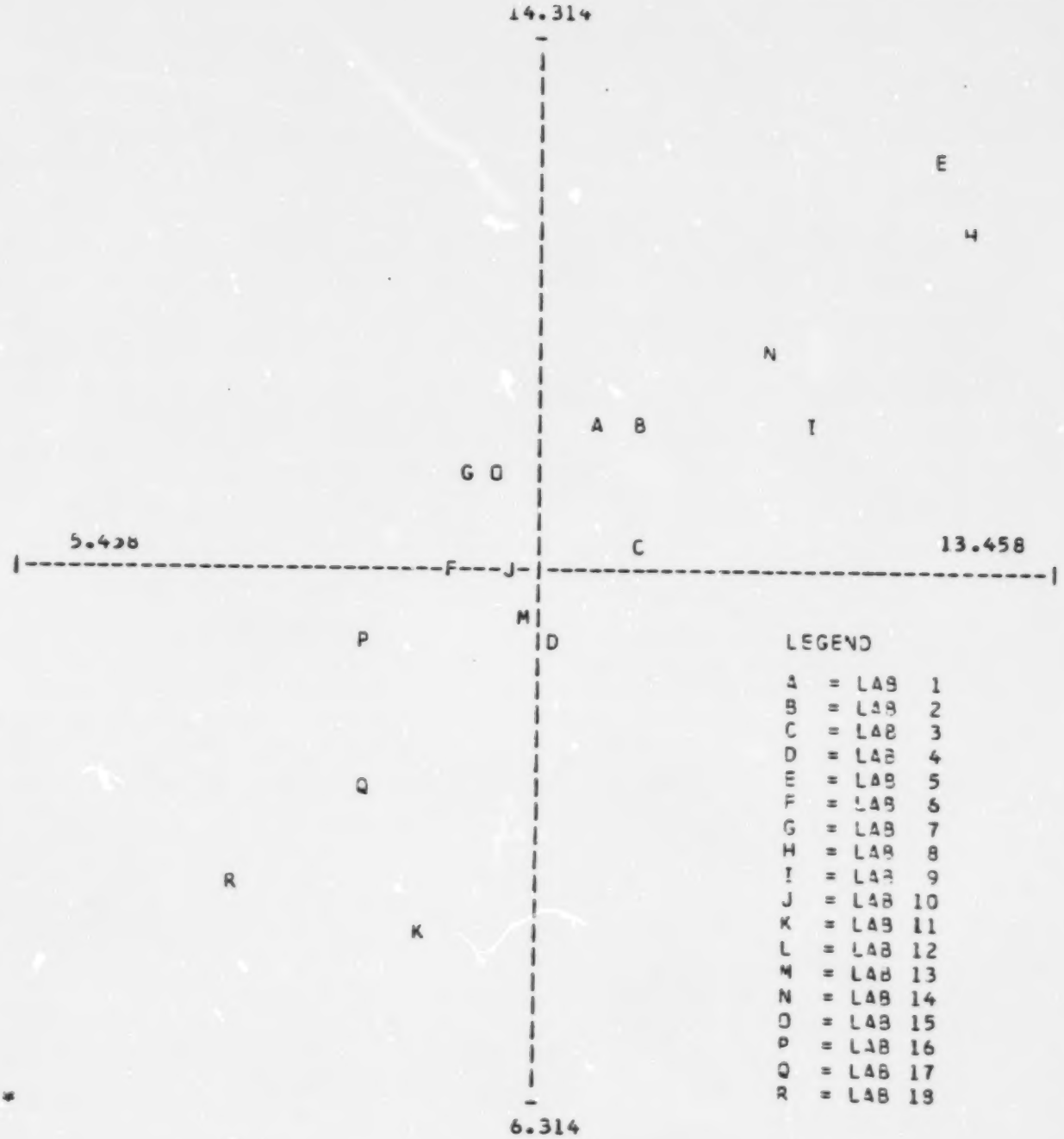
TYPE OF PRECISION	MEAN TEST VALUES		
	Correlation 10.4	11.3	ASTM
Single Laboratory 95% Difference Limit	1.5	1.2	not available
Multi Laboratory 95% Difference Limit	4.0	3.1	not available

Table Precision over a range of values.
MTC LABS ONLY

TEST 32: HOT MIX, MARSHALL FLOW, 0.025MM UNITS
TEST PERIOD: 81

SCATTER PLOT ANALYSIS
SCALE: 0.444 UNITS=1 CM

HORIZONTAL AXIS: MATERIAL 1
VERTICAL AXIS: MATERIAL 2

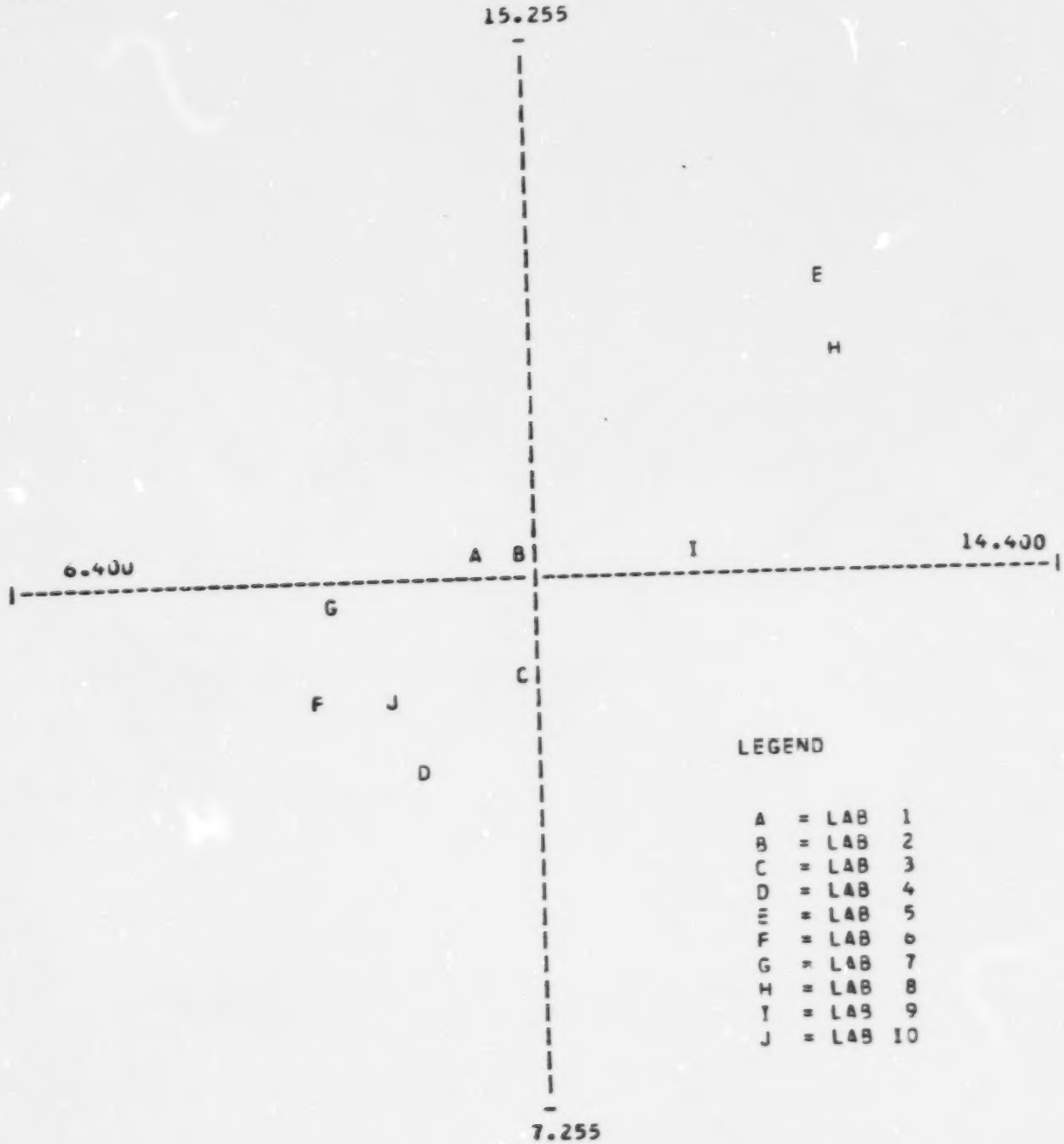


	MATERIAL 1	MATERIAL 2
MEAN	9.458	10.314
STANDARD DEVIATION	1.973	1.827
STANDARD ERROR OF THE MEAN	0.329	0.304

TEST 32: HOT MIX, MARSHALL FLOW, 0.025MM UNITS MTC LABS ONLY
TEST PERIOD: 01

SCATTER PLOT ANALYSIS
SCALE: 0.444 UNITS=1 CM

HORIZONTAL AXIS: MATERIAL 1
VERTICAL AXIS: MATERIAL 2



LEGEND

A = LAB 1
B = LAB 2
C = LAB 3
D = LAB 4
E = LAB 5
F = LAB 6
G = LAB 7
H = LAB 8
I = LAB 9
J = LAB 10

	MATERIAL 1	MATERIAL 2
MEAN	10.400	11.255
STANDARD DEVIATION	1.492	1.173
STANDARD ERROR OF THE MEAN	0.33	0.262

Test 40: Asphalt Cement Content By Mass

Method MTC LS-282

Reference ASTM D2172-75

This test determines the asphalt cement content of a bituminous mixture.

Eighteen laboratories took part in the test. Laboratories K & M should probably check out their procedure and/or equipment. The precision limits as determined by this round of tests was within the ASTM D2S limits. The shape of the scatter diagram indicates that this test appears in control.

TEST 40: HOT MIX,PREPARED SAMPLE,% ASPHALT CEMENT BY MASS
TEST PERIOD: 61

TABLE OF TEST RESULTS

	MATERIAL 1		MATERIAL 2	
LAB 1 OPERATOR 1	5.540	5.470	5.250	5.200
LAB 2 OPERATOR 1	5.550	5.670	5.390	5.360
LAB 3 OPERATOR 1	5.510	5.600	5.260	5.260
LAB 4 OPERATOR 1	5.440	5.560	5.140	5.270
LAB 5 OPERATOR 1	5.510	5.570	5.440	5.480
LAB 6 OPERATOR 1	5.650	5.570	5.380	5.320
LAB 7 OPERATOR 1	5.390	5.370	5.370	5.460
LAB 8 OPERATOR 1	5.600	5.590	5.560	5.520
LAB 9 OPERATOR 1	5.770	5.810	5.400	5.260
LAB 10 OPERATOR 1	5.490	5.520	5.240	5.230
LAB 11 OPERATOR 1	5.800	6.000	5.600	5.600
LAB 12 OPERATOR 1	5.380	5.440	5.430	5.640
LAB 13 OPERATOR 1	6.400	5.920	5.780	5.680
LAB 14 OPERATOR 1	5.560	5.550	5.430	5.230
LAB 15 OPERATOR 1	5.610	5.700	5.450	5.390
LAB 16 OPERATOR 1	5.760	5.660	5.570	5.210
LAB 17 OPERATOR 1	5.670	5.520	5.210	5.360
LAB 18 OPERATOR 1	5.400	6.000	5.300	5.300
RANGES	1.030		0.640	

TEST 40: HOT MIX, PREPARED SAMPLE, % ASPHALT CEMENT BY MASS
TEST PERIOD: 81

WITHIN-LABORATORY AVERAGES AND STANDARD DEVIATIONS

LAB	AVERAGE	SIGMA
MATERIAL 1		
LAB 1	5.505	0.049
LAB 2	5.610	0.085
LAB 3	5.555	0.063
LAB 4	5.500	0.085
LAB 5	5.540	0.042
LAB 6	5.610	0.056
LAB 7	5.580	0.013
LAB 8	5.595	0.006
LAB 9	5.790	0.028
LAB 10	5.505	0.021
LAB 11	5.900	0.141
LAB 12	5.410	0.042
LAB 13	6.160	0.339
LAB 14	5.555	0.007
LAB 15	5.655	0.064
LAB 16	5.710	0.071
LAB 17	5.595	0.106
LAB 18	5.700	0.424
MATERIAL 2		
LAB 1	5.225	0.035
LAB 2	5.385	0.006
LAB 3	5.260	0.003
LAB 4	5.205	0.092
LAB 5	5.460	0.028
LAB 6	5.350	0.042
LAB 7	5.415	0.064
LAB 8	5.540	0.028
LAB 9	5.330	0.099
LAB 10	5.235	0.007
LAB 11	5.600	0.004
LAB 12	5.535	0.148
LAB 13	5.730	0.071
LAB 14	5.330	0.141
LAB 15	5.420	0.042
LAB 16	5.390	0.255
LAB 17	5.285	0.106
LAB 18	5.300	0.004

TEST 40: ASPHALT CEMENT CONTENT BY MASS

TYPE OF PRECISION	MEAN TEST VALUES		
	Correlation 5.4	5.6	ASTM
Single Laboratory 95% Difference Limit	0.26	0.40	0.52
Multi Laboratory 95% Difference Limit	0.42	0.63	0.81

Table Precision over a range of values.
ALL LABORATORIES

TEST 40

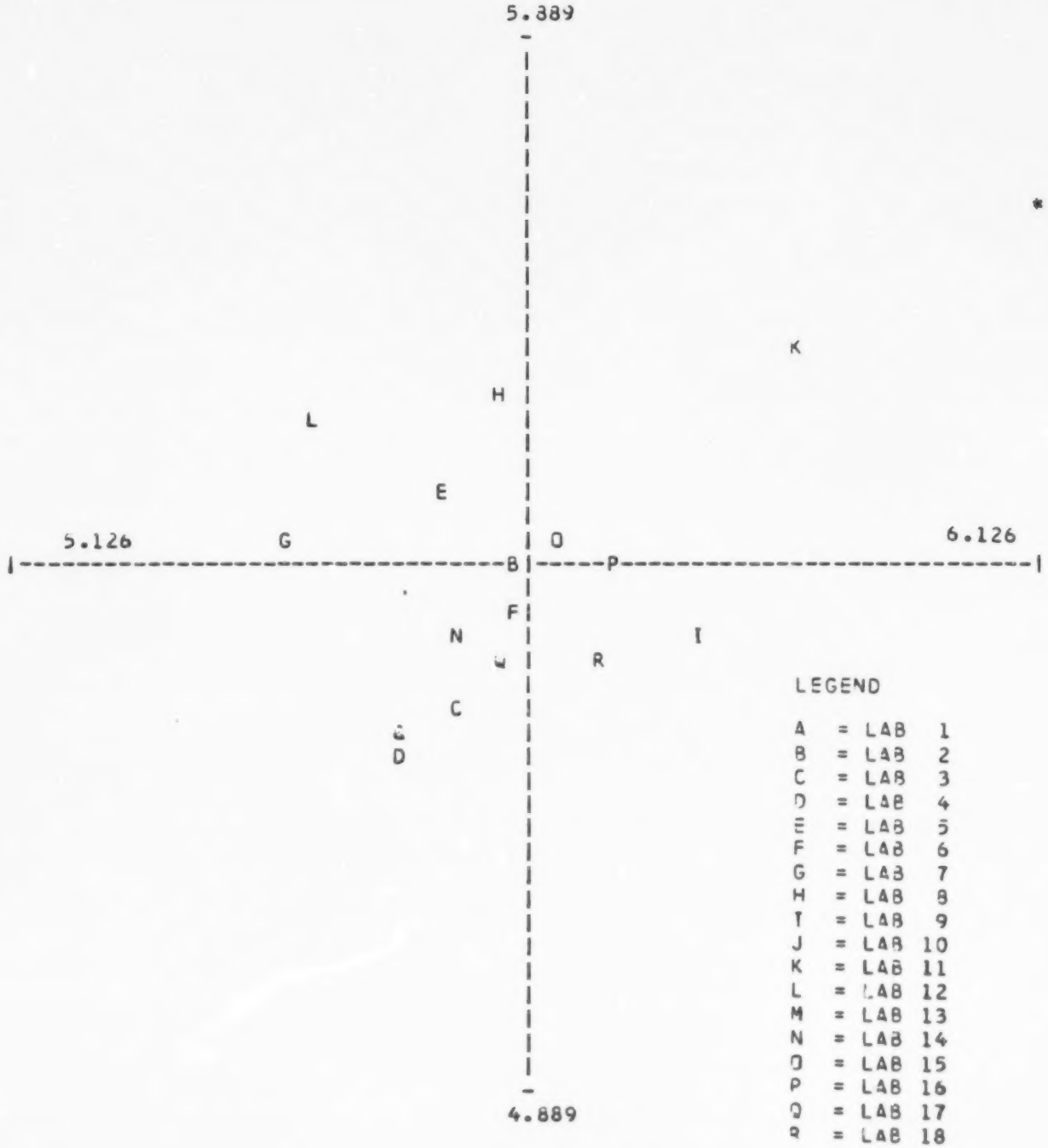
TYPE OF PRECISION	MEAN TEST VALUES		
	Correlation 5.3	5.6	ASTM
Single Laboratory 95% Difference Limit	0.15	0.15	0.52
Multi Laboratory 95% Difference Limit	0.30	0.30	0.81

Table Precision over a range of values.
MTC LABS ONLY

TEST 40: HOT MIX,PREPARED SAMPLE,% ASPHALT CEMENT BY MASS
TEST PERIOD: 81

SCATTER PLOT ANALYSIS
SCALE: 0.055 UNITS=1 CM

HORIZONTAL AXIS: MATERIAL 1
VERTICAL AXIS: MATERIAL 2



LEGEND

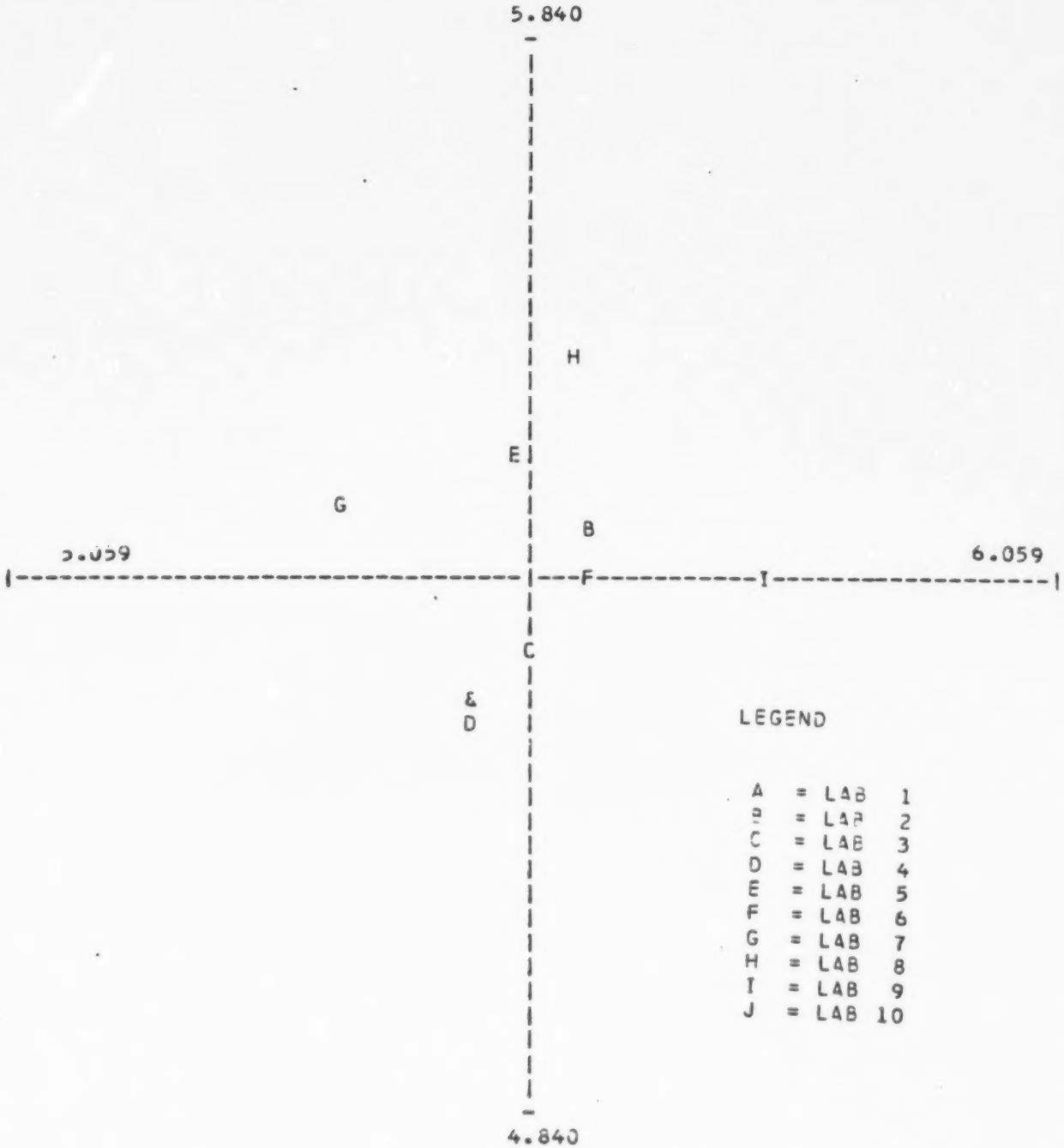
A	=	LAB 1
B	=	LAB 2
C	=	LAB 3
D	=	LAB 4
E	=	LAB 5
F	=	LAB 6
G	=	LAB 7
H	=	LAB 8
I	=	LAB 9
J	=	LAB 10
K	=	LAB 11
L	=	LAB 12
M	=	LAB 13
N	=	LAB 14
O	=	LAB 15
P	=	LAB 16
Q	=	LAB 17
R	=	LAB 18

	MATERIAL 1	MATERIAL 2
MEAN	5.626	5.389
STANDARD DEVIATION	0.208	0.154
STANDARD ERROR OF THE MEAN	0.035	0.026

TEST 40: HOT MIX,PREPARED SAMPLE,% ASPHALT CEMENT BY MASS MTC LABS ONLY
TEST PERIOD: 61

SCATTER PLOT ANALYSIS
SCALE: 0.055 UNITS=1 CM

HORIZONTAL AXIS: MATERIAL 1
VERTICAL AXIS: MATERIAL 2



LEGEND

A = LAB 1
B = LAB 2
C = LAB 3
D = LAB 4
E = LAB 5
F = LAB 6
G = LAB 7
H = LAB 8
I = LAB 9
J = LAB 10

	MATERIAL 1	MATERIAL 2
MEAN	5.559	5.340
STANDARD DEVIATION	0.110	0.115
STANDARD ERROR OF THE MEAN	0.025	0.026

Tests 44 to 54: Percent Aggregate Retained on Sieves

Method MTC LS-282

These tests identify the accumulative percentage of aggregate from a bituminous mixture which has had the asphalt cement extracted from it. To save space these tests will all be discussed at once rather than individually.

Eighteen laboratories were involved in the tests. It appears that lab R is an outlier on its results for the coarse aggregate sieves, lab R manages to fall back into the pack below the 1.18 mm sieve. Labs N & K appear to be outliers on the 300 um and 75 um sieve.

In analyzing the data, one has to take into account how the samples were made up. The coarse fractions from the 16.0 mm to the 4.75 mm sieve were added for each individual sieve. Below the 4.75 mm sieve, the material was added as a pass 4.75 mm retained 75 um sieve graded product (washed). Then the pass 75 um sieve portion was added separately.

TEST 44: HOT MIX,PREP. SAMP.,% AGGREG. RETAINED ON THE 16.0MM SIEVE
TEST PERIOD: 81

TABLE OF TEST RESULTS

	MATERIAL 1		MATERIAL 2	
LAB 1 OPERATOR 1	1.600	0.000	0.000	0.000
LAB 2 OPERATOR 1	0.700	0.800	1.300	0.000
LAB 3 OPERATOR 1	0.000	0.000	1.100	0.000
LAB 4 OPERATOR 1	0.000	0.000	0.000	0.000
LAB 5 OPERATOR 1	1.000	1.000	0.000	0.000
LAB 6 OPERATOR 1	0.000	0.000	0.000	0.000
LAB 7 OPERATOR 1	0.000	0.700	0.000	0.000
LAB 8 OPERATOR 1	0.000	3.200	0.800	0.700
LAB 9 OPERATOR 1	1.500	0.900	0.000	0.000
LAB 10 OPERATOR 1	0.600	0.700	0.000	0.000
LAB 11 OPERATOR 1	1.300	0.600	0.000	1.200
LAB 12 OPERATOR 1	0.000	0.000	0.000	0.800
LAB 13 OPERATOR 1	0.000	0.700	0.000	0.000
LAB 14 OPERATOR 1	2.300	0.700	0.000	0.000
LAB 15 OPERATOR 1	0.000	1.200	0.800	0.000
LAB 16 OPERATOR 1	1.500	0.000	0.000	0.000
LAB 17 OPERATOR 1	0.000	0.000	0.000	0.000
LAB 18 OPERATOR 1	0.000	1.300	0.000	0.000
RANGES	3.200		1.300	

TEST 44: HOT MIX,PREP. SAMP.,% AGGREG. RETAINED ON THE 16.0MM SIEVE
TEST PERIOD: 81

WITHIN-LABORATORY AVERAGES AND STANDARD DEVIATIONS

LAB	AVERAGE	SIGMA
MATERIAL 1		
LAB 1	0.800	1.131
LAB 2	0.750	0.071
LAB 3	0.000	0.000
LAB 4	0.000	0.000
LAB 5	1.000	0.000
LAB 6	0.000	0.000
LAB 7	0.350	0.495
LAB 8	1.600	1.263
LAB 9	1.200	0.424
LAB 10	0.650	0.071
LAB 11	0.950	0.495
LAB 12	0.000	0.000
LAB 13	0.350	0.495
LAB 14	1.500	1.131
LAB 15	0.600	0.849
LAB 16	0.750	1.061
LAB 17	0.000	0.000
LAB 18	0.650	0.919
MATERIAL 2		
LAB 1	0.000	0.000
LAB 2	0.650	0.919
LAB 3	0.550	0.778
LAB 4	0.000	0.000
LAB 5	0.000	0.000
LAB 6	0.000	0.000
LAB 7	0.000	0.000
LAB 8	0.750	0.071
LAB 9	0.000	0.000
LAB 10	0.000	0.000
LAB 11	0.600	0.849
LAB 12	0.400	0.566
LAB 13	0.000	0.000
LAB 14	0.000	0.000
LAB 15	0.400	0.566
LAB 16	0.000	0.000
LAB 17	0.000	0.000
LAB 18	0.000	0.000

TEST 44: HOT MIX,PREP. SAMP.,& AGGREG. RETAINED ON THE 1c.0MM SIEVE
TEST PERIOD: 81

TABLE OF TEST RESULTS

	MATERIAL 1		MATERIAL 2	
LAB 1 OPERATOR 1	1.000	0.000	0.000	0.000
LAB 2 OPERATOR 1	0.700	0.000	1.300	0.000
LAB 3 OPERATOR 1	0.000	0.000	1.100	0.000
LAB 4 OPERATOR 1	0.000	0.000	0.000	0.000
LAB 5 OPERATOR 1	1.000	1.000	0.000	0.000
LAB 6 OPERATOR 1	0.000	0.000	0.000	0.000
LAB 7 OPERATOR 1	0.000	0.700	0.000	0.000
LAB 8 OPERATOR 1	0.000	3.200	0.800	0.700
LAB 9 OPERATOR 1	1.500	0.900	0.000	0.000
LAB 10 OPERATOR 1	0.600	0.700	0.000	0.000
LAB 11 OPERATOR 1	1.300	0.600	0.000	1.200
LAB 12 OPERATOR 1	0.000	0.000	0.000	0.800
LAB 13 OPERATOR 1	0.000	0.700	0.000	0.000
LAB 14 OPERATOR 1	2.300	0.700	0.000	0.000
LAB 15 OPERATOR 1	0.000	1.200	0.800	0.000
LAB 16 OPERATOR 1	1.500	0.000	0.000	0.000
LAB 17 OPERATOR 1	0.000	0.000	0.000	0.000
LAB 18 OPERATOR 1	0.000	1.300	0.000	0.000
RANGES	3.200		1.300	

TEST 44: HOT MIX.PREP. SAMP.,& AGGREG. RETAINED ON THE 16.0MM SIEVE
TEST PERIOD: 81

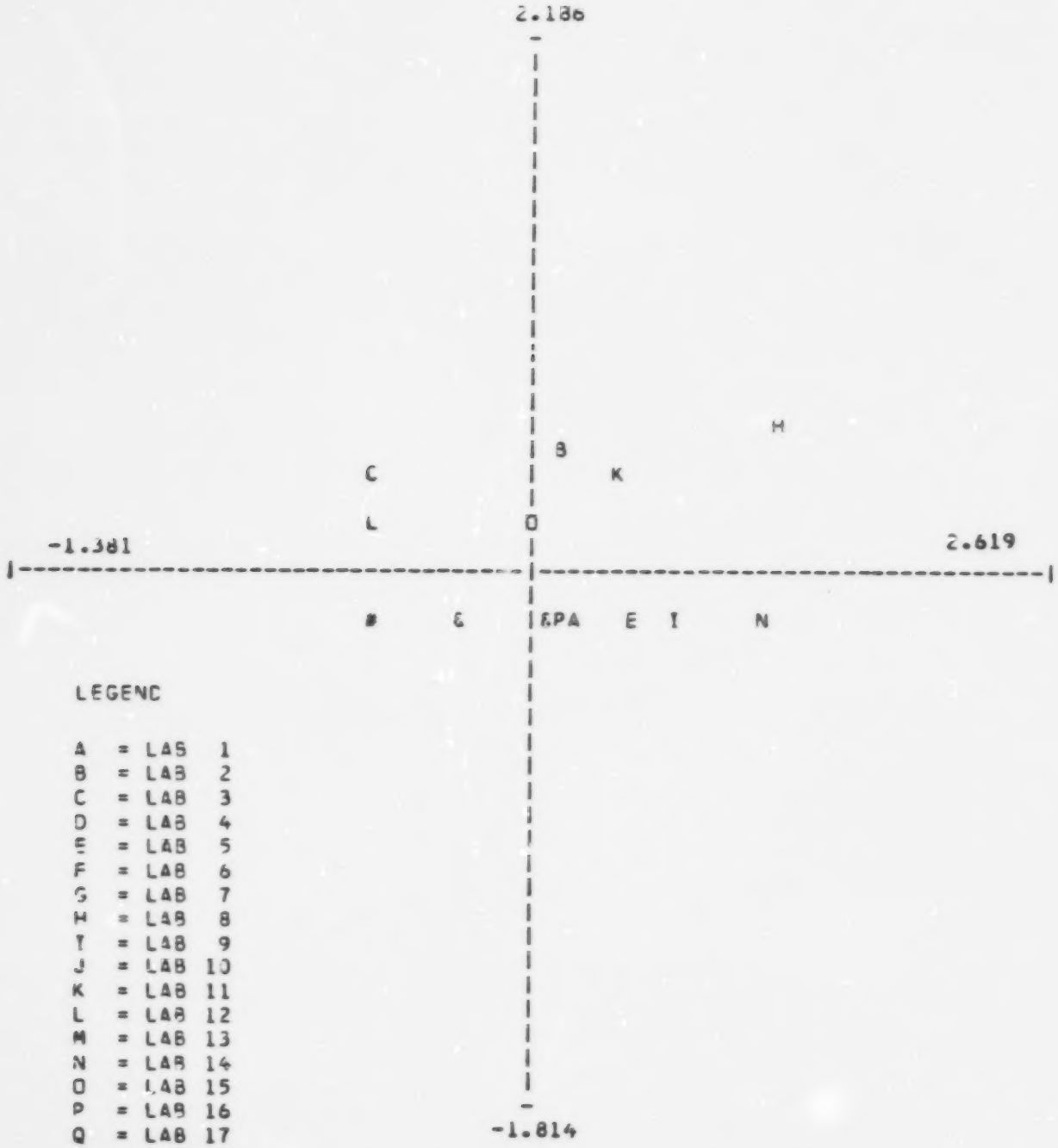
WITHIN-LABORATORY AVERAGES AND STANDARD DEVIATIONS

LAB	AVERAGE	SIGMA
MATERIAL 1		
LAB 1	0.800	1.131
LAB 2	0.750	0.071
LAB 3	0.000	0.000
LAB 4	0.000	0.000
LAB 5	1.000	0.000
LAB 6	0.000	0.000
LAB 7	0.350	0.495
LAB 8	1.600	0.283
LAB 9	1.200	0.424
LAB 10	0.650	0.071
LAB 11	0.950	0.495
LAB 12	0.000	0.000
LAB 13	0.350	0.495
LAB 14	1.500	1.131
LAB 15	0.600	0.849
LAB 16	0.750	1.061
LAB 17	0.000	0.000
LAB 18	0.650	0.919
MATERIAL 2		
LAB 1	0.000	0.000
LAB 2	0.650	0.919
LAB 3	0.550	0.776
LAB 4	0.000	0.000
LAB 5	0.000	0.000
LAB 6	0.000	0.000
LAB 7	0.000	0.000
LAB 8	0.750	0.071
LAB 9	0.000	0.000
LAB 10	0.000	0.000
LAB 11	0.600	0.849
LAB 12	0.400	0.566
LAB 13	0.000	0.000
LAB 14	0.000	0.000
LAB 15	0.400	0.566
LAB 16	0.000	0.000
LAB 17	0.000	0.000
LAB 18	0.000	0.000

TEST 44: HOT MIX,PREP. SAMP.,% AGGREG. RETAINED ON THE 16.0MM SIEVE BY MASS
TEST PERIOD: 81

SCATTER PLOT ANALYSIS
SCALE: 0.222 UNITS=1 CM

HORIZONTAL AXIS: MATERIAL 1
VERTICAL AXIS: MATERIAL 2



LEGEND

A = LAB 1
B = LAB 2
C = LAB 3
D = LAB 4
E = LAB 5
F = LAB 6
G = LAB 7
H = LAB 8
I = LAB 9
J = LAB 10
K = LAB 11
L = LAB 12
M = LAB 13
N = LAB 14
O = LAB 15
P = LAB 16
Q = LAB 17
R = LAB 18

	MATERIAL 1	MATERIAL 2
MEAN	0.619	0.186
STANDARD DEVIATION	0.760	0.397
STANDARD ERROR OF THE MEAN	0.127	0.066

TEST 45: HOT MIX,PREP. SAMP.,& AGGREG. RETAINED ON THE 13.2MM SIEVE
TEST PERIOD: 61

TABLE OF TEST RESULTS

	MATERIAL 1		MATERIAL 2	
LAB 1 OPERATOR 1	8.200	8.800	8.600	8.300
LAB 2 OPERATOR 1	8.700	7.800	8.600	8.500
LAB 3 OPERATOR 1	8.700	7.000	8.300	8.200
LAB 4 OPERATOR 1	8.300	7.900	7.400	7.000
LAB 5 OPERATOR 1	7.000	8.300	8.000	9.000
LAB 6 OPERATOR 1	7.000	8.000	8.000	8.000
LAB 7 OPERATOR 1	8.100	7.600	8.100	7.600
LAB 8 OPERATOR 1	7.600	9.100	7.800	9.500
LAB 9 OPERATOR 1	8.700	7.400	7.900	8.600
LAB 10 OPERATOR 1	8.700	8.200	8.700	7.000
LAB 11 OPERATOR 1	9.400	9.100	10.100	9.200
LAB 12 OPERATOR 1	10.300	10.100	10.100	9.350
LAB 13 OPERATOR 1	9.300	7.900	8.100	8.300
LAB 14 OPERATOR 1	10.300	10.500	11.600	10.900
LAB 15 OPERATOR 1	10.000	12.300	10.100	10.600
LAB 16 OPERATOR 1	6.700	7.200	8.500	7.000
LAB 17 OPERATOR 1	12.500	14.900	0.000	0.000
LAB 18 OPERATOR 1	9.300	9.000	9.900	11.600
RANGES	9.600		11.600	

TEST 43: HOT MIX,PREP. SAMP.,% AGGREG. RETAINED ON THE 13.2MM SIEVE
TEST PERIOD: 81

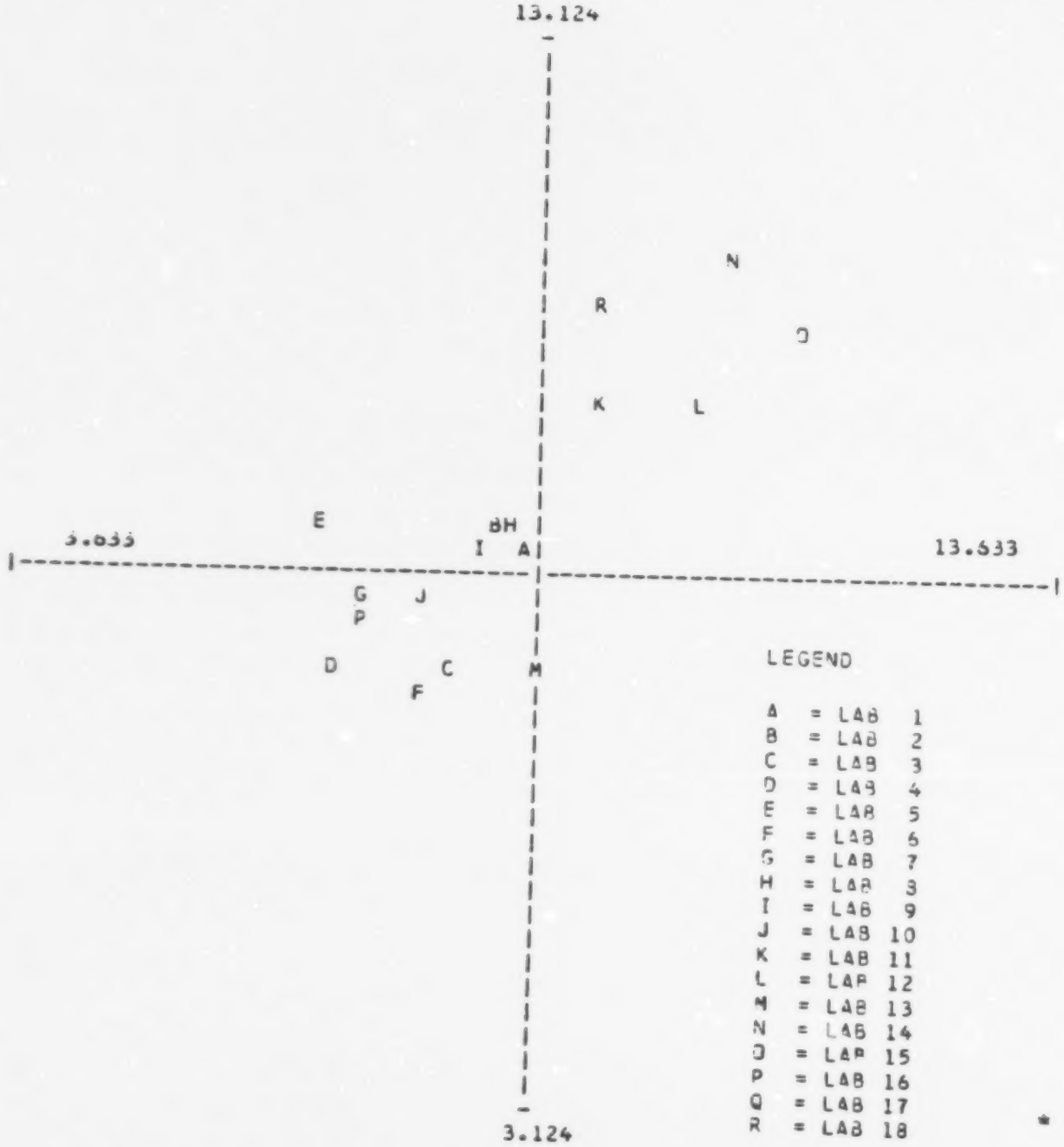
WITHIN-LABORATORY AVERAGES AND STANDARD DEVIATIONS

LAB	AVERAGE	SIGMA
MATERIAL 1		
LAB 1	8.500	0.425
LAB 2	8.450	0.637
LAB 3	7.850	1.202
LAB 4	8.600	1.838
LAB 5	8.500	0.707
LAB 6	7.500	0.707
LAB 7	8.950	1.202
LAB 8	8.350	1.061
LAB 9	8.050	0.919
LAB 10	7.450	1.061
LAB 11	9.250	0.213
LAB 12	10.200	0.142
LAB 13	8.600	0.990
LAB 14	10.400	0.142
LAB 15	11.150	1.626
LAB 16	6.950	0.354
LAB 17	13.700	1.697
LAB 18	9.150	0.213
MATERIAL 2		
LAB 1	8.450	0.212
LAB 2	8.550	0.072
LAB 3	7.250	1.485
LAB 4	7.200	0.283
LAB 5	8.500	0.707
LAB 6	7.000	1.414
LAB 7	7.850	0.354
LAB 8	8.650	1.202
LAB 9	8.250	0.495
LAB 10	7.850	1.202
LAB 11	9.650	0.637
LAB 12	9.725	0.530
LAB 13	7.200	1.273
LAB 14	11.250	0.495
LAB 15	10.350	0.354
LAB 16	7.750	1.061
LAB 17	0.000	0.000
LAB 18	10.750	1.202

TEST 45: HOT MIX,PREP. SAMP..& AGGREG. RETAINED ON THE 13.2MM SIEVE BY MASS
TEST PERIOD: 01

SCATTER PLOT ANALYSIS
SCALE: 0.555 UNITS=1 CM

HORIZONTAL AXIS: MATERIAL 1
VERTICAL AXIS: MATERIAL 2



LEGEND

A	= LAB	1
B	= LAB	2
C	= LAB	3
D	= LAB	4
E	= LAB	5
F	= LAB	6
G	= LAB	7
H	= LAB	8
I	= LAB	9
J	= LAB	10
K	= LAB	11
L	= LAB	12
M	= LAB	13
N	= LAB	14
O	= LAB	15
P	= LAB	16
Q	= LAB	17
R	= LAB	18

	MATERIAL 1	MATERIAL 2
MEAN	8.633	8.124
STANDARD DEVIATION	1.932	2.437
STANDARD ERROR OF THE MEAN	0.322	0.406

TEST 46: HOT MIX,PREP. SAMP.,% AGGREG. RETAINED ON THE 9.5MM SIEVE
TEST PERIOD: 81

TABLE OF TEST RESULTS

	MATERIAL 1		MATERIAL 2	
LAB 1 OPERATOR 1	25.100	22.100	26.300	25.700
LAB 2 OPERATOR 1	24.200	25.300	26.100	27.200
LAB 3 OPERATOR 1	23.500	23.600	25.800	24.700
LAB 4 OPERATOR 1	23.900	23.300	26.100	25.100
LAB 5 OPERATOR 1	24.000	24.000	25.000	25.000
LAB 6 OPERATOR 1	23.000	23.000	25.000	24.000
LAB 7 OPERATOR 1	23.100	23.500	25.300	24.200
LAB 8 OPERATOR 1	24.600	24.600	26.200	26.400
LAB 9 OPERATOR 1	24.600	25.100	25.200	25.500
LAB 10 OPERATOR 1	23.900	23.400	27.300	26.100
LAB 11 OPERATOR 1	25.600	25.100	27.000	27.600
LAB 12 OPERATOR 1	23.700	24.400	27.200	25.900
LAB 13 OPERATOR 1	23.600	23.300	27.500	25.100
LAB 14 OPERATOR 1	23.900	23.600	25.600	26.000
LAB 15 OPERATOR 1	24.300	23.300	26.200	26.600
LAB 16 OPERATOR 1	24.900	24.300	26.400	26.300
LAB 17 OPERATOR 1	25.600	25.600	26.800	27.000
LAB 18 OPERATOR 1	24.600	27.300	23.300	24.800
RANGES	5.200		4.300	

TEST 40: HOT MIX,PREP. SAMP.,% AGGREG. RETAINED ON THE 9.5MM SIEVE
TEST PERIOD: 81

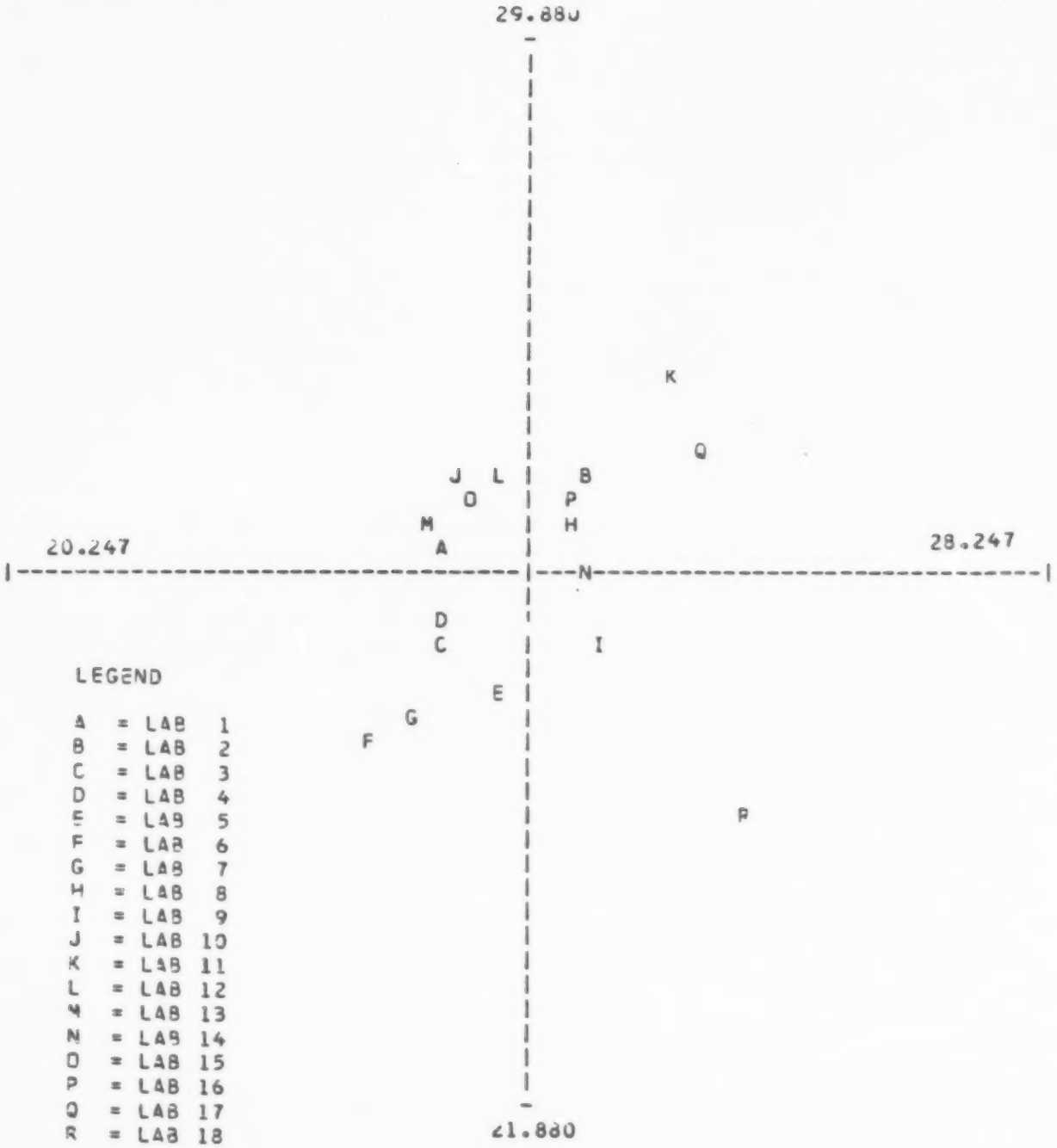
WITHIN-LABORATORY AVERAGES AND STANDARD DEVIATIONS

LAB	AVERAGE	SIGMA
MATERIAL 1		
LAB 1	23.600	2.121
LAB 2	24.750	0.778
LAB 3	23.550	0.071
LAB 4	23.600	0.424
LAB 5	24.000	0.000
LAB 6	23.000	0.000
LAB 7	23.300	0.283
LAB 8	24.600	0.016
LAB 9	24.850	0.353
LAB 10	23.650	0.353
LAB 11	25.350	0.353
LAB 12	24.050	0.495
LAB 13	23.450	0.212
LAB 14	24.750	1.202
LAB 15	23.800	0.707
LAB 16	24.600	0.424
LAB 17	25.600	0.016
LAB 18	25.950	1.909
MATERIAL 2		
PROVINCE		
LAB 1	26.000	0.424
LAB 2	26.650	0.778
LAB 3	25.250	0.778
LAB 4	25.600	0.707
LAB 5	25.000	0.000
LAB 6	24.500	0.707
LAB 7	24.750	0.778
LAB 8	26.300	0.140
LAB 9	25.350	0.212
LAB 10	26.700	0.849
LAB 11	27.300	0.424
LAB 12	26.550	0.919
LAB 13	26.300	1.697
LAB 14	25.800	0.283
LAB 15	26.500	0.424
LAB 16	26.350	0.069
LAB 17	26.900	0.141
LAB 18	24.050	1.061

TEST 46: HOT MIX,PREP. SAMP.,& AGGREG. RETAINED ON THE 9.5MM SIEVE BY MASS
TEST PERIOD: 81

SCATTER PLOT ANALYSIS
SCALE: 0.444 UNITS=1 CM

HORIZONTAL AXIS: MATERIAL 1
VERTICAL AXIS: MATERIAL 2



LEGEND

A	= LAB	1
B	= LAB	2
C	= LAB	3
D	= LAB	4
E	= LAB	5
F	= LAB	6
G	= LAB	7
H	= LAB	8
I	= LAB	9
J	= LAB	10
K	= LAB	11
L	= LAB	12
M	= LAB	13
N	= LAB	14
O	= LAB	15
P	= LAB	16
Q	= LAB	17
R	= LAB	18

	MATERIAL 1	MATERIAL 2
MEAN	24.247	25.880
STANDARD DEVIATION	1.016	1.025
STANDARD ERROR OF THE MEAN	0.169	0.171

TEST 47: HOT MIX,PREP. SAMP.,% AGGREG. RETAINED ON THE 0.7MM SIEVE
TEST PERIOD: 81

TABLE OF TEST RESULTS

	MATERIAL 1		MATERIAL 2	
LAB 1 OPERATOR 1	33.700	33.000	37.300	36.700
LAB 2 OPERATOR 1	34.500	34.300	37.600	37.600
LAB 3 OPERATOR 1	32.500	32.800	36.100	36.500
LAB 4 OPERATOR 1	33.300	33.700	36.500	36.900
LAB 5 OPERATOR 1	34.000	33.000	37.000	37.000
LAB 6 OPERATOR 1	34.000	33.000	37.000	37.000
LAB 7 OPERATOR 1	33.900	32.800	37.100	36.100
LAB 8 OPERATOR 1	33.500	33.700	37.200	36.800
LAB 9 OPERATOR 1	34.100	34.200	37.300	37.400
LAB 10 OPERATOR 1	34.500	34.200	38.500	37.800
LAB 11 OPERATOR 1	34.200	34.300	37.800	37.300
LAB 13 OPERATOR 1	34.300	34.100	38.800	38.700
LAB 14 OPERATOR 1	35.800	35.700	38.200	39.600
LAB 15 OPERATOR 1	35.100	35.100	39.200	39.800
LAB 16 OPERATOR 1	33.900	33.500	37.100	37.000
LAB 18 OPERATOR 1	32.200	32.700	33.600	36.200
RANGES	3.600		6.200	

TEST 47: HOT MIX,PREP. SAMP.,% AGGREG. RETAINED ON THE 6.7MM SIEVE
TEST PERIOD: 81

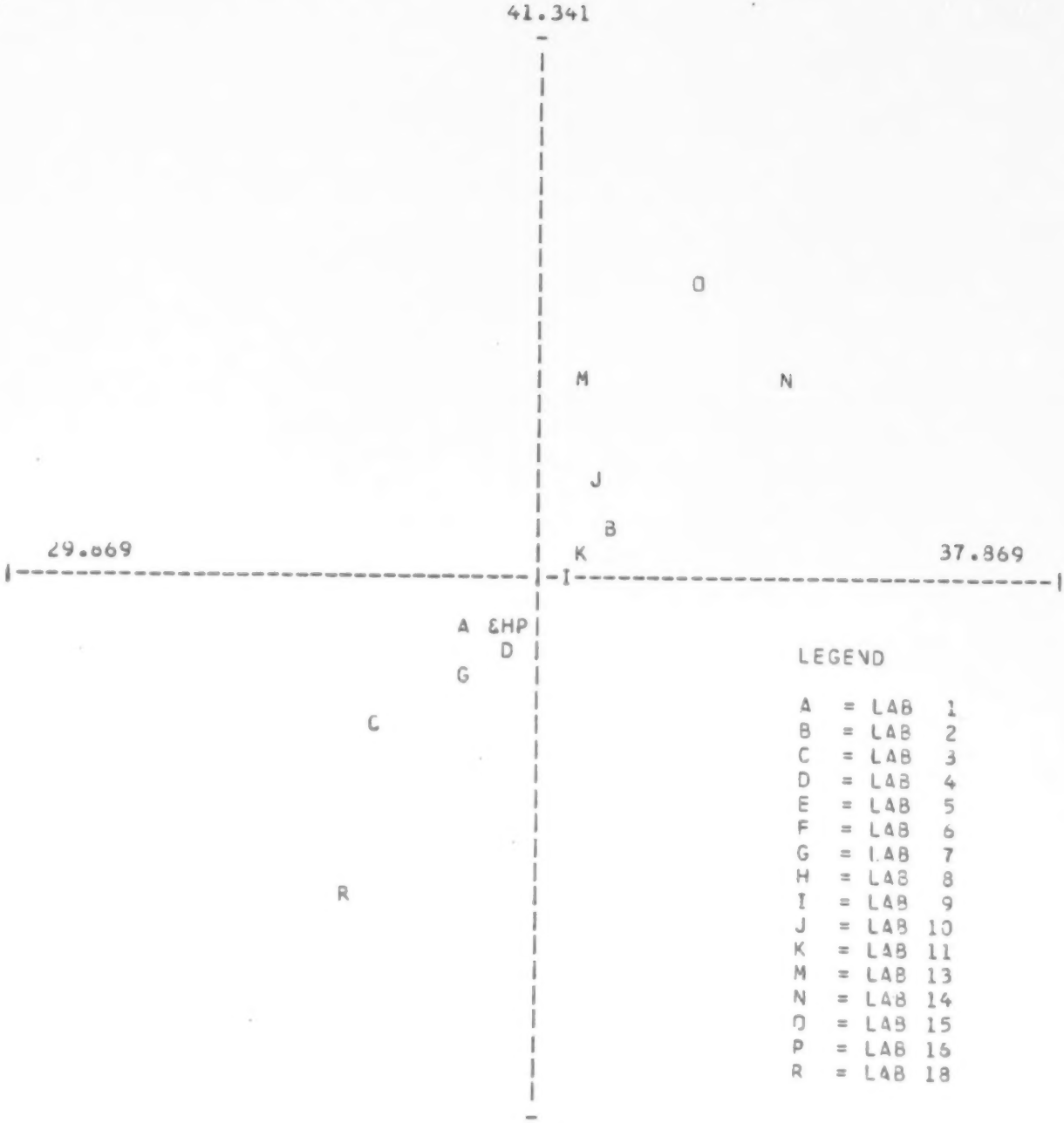
WITHIN-LABORATORY AVERAGES AND STANDARD DEVIATIONS

LAB	AVERAGE	SIGMA
MATERIAL 1		
LAB 1	33.350	0.496
LAB 2	34.400	0.142
LAB 3	32.650	0.215
LAB 4	33.600	0.147
LAB 5	33.500	0.707
LAB 6	33.500	0.707
LAB 7	33.350	0.776
LAB 8	33.600	0.147
LAB 9	34.150	0.075
LAB 10	34.350	0.214
LAB 11	34.250	0.075
LAB 13	34.200	0.145
LAB 14	35.750	0.075
LAB 15	35.100	0.031
LAB 16	33.700	0.284
LAB 18	32.450	0.354
MATERIAL 2		
LAB 1	37.000	0.425
LAB 2	37.700	0.141
LAB 3	36.300	0.283
LAB 4	36.700	0.283
LAB 5	37.000	0.000
LAB 6	37.000	0.000
LAB 7	36.600	0.708
LAB 8	37.000	0.284
LAB 9	37.350	0.075
LAB 10	38.150	0.495
LAB 11	37.550	0.355
LAB 13	38.750	0.075
LAB 14	38.900	0.990
LAB 15	39.500	0.425
LAB 16	37.050	0.070
LAB 18	34.900	1.839

TEST 47: HOT MIX,PREP. SAMP.,% AGGREG. RETAINED ON THE 6.7MM SIEVE BY MA
TEST PERIOD: 81

SCATTER PLOT ANALYSIS
SCALE: 0.444 UNITS=1 CM

HORIZONTAL AXIS: MATERIAL
VERTICAL AXIS: MATERIAL



LEGEND

A	=	LAB 1
B	=	LAB 2
C	=	LAB 3
D	=	LAB 4
E	=	LAB 5
F	=	LAB 6
G	=	LAB 7
H	=	LAB 8
I	=	LAB 9
J	=	LAB 10
K	=	LAB 11
M	=	LAB 13
N	=	LAB 14
O	=	LAB 15
P	=	LAB 16
R	=	LAB 18

	MATERIAL 1	MATERIAL 2
MEAN	33.869	37.341
STANDARD DEVIATION	0.863	1.176
STANDARD ERROR OF THE MEAN	0.153	0.208

TEST 46: HOT MIX,PREP. SAMP.,% AGGREG. RETAINED ON THE 4.75MM SIEVE
TEST PERIOD: 81

TABLE OF TEST RESULTS

	MATERIAL 1		MATERIAL 2	
LAB 1 OPERATOR 1	40.800	40.500	45.400	45.400
LAB 2 OPERATOR 1	41.100	41.200	45.400	45.400
LAB 3 OPERATOR 1	40.100	40.000	45.400	45.300
LAB 4 OPERATOR 1	40.800	40.700	45.400	45.200
LAB 5 OPERATOR 1	40.500	40.800	45.300	45.400
LAB 6 OPERATOR 1	40.400	40.100	45.400	45.300
LAB 7 OPERATOR 1	40.200	40.500	44.900	45.000
LAB 8 OPERATOR 1	40.300	40.700	45.700	45.600
LAB 9 OPERATOR 1	40.100	40.500	45.700	45.100
LAB 10 OPERATOR 1	40.800	40.800	45.400	45.500
LAB 11 OPERATOR 1	42.000	41.300	46.000	45.900
LAB 12 OPERATOR 1	40.600	40.600	46.200	46.000
LAB 13 OPERATOR 1	40.100	40.200	45.300	45.300
LAB 14 OPERATOR 1	41.700	41.500	44.400	45.700
LAB 15 OPERATOR 1	40.900	40.600	45.500	45.900
LAB 16 OPERATOR 1	41.000	40.500	45.600	45.400
LAB 17 OPERATOR 1	40.900	41.500	45.500	45.700
LAB 18 OPERATOR 1	39.800	39.300	41.500	43.800
RANGES	2.300		4.700	

TEST 46: HOT MIX,PREP. SAMP.,% AGGREG. RETAINED ON THE 4.75MM SIEVE
TEST PERIOD: 81

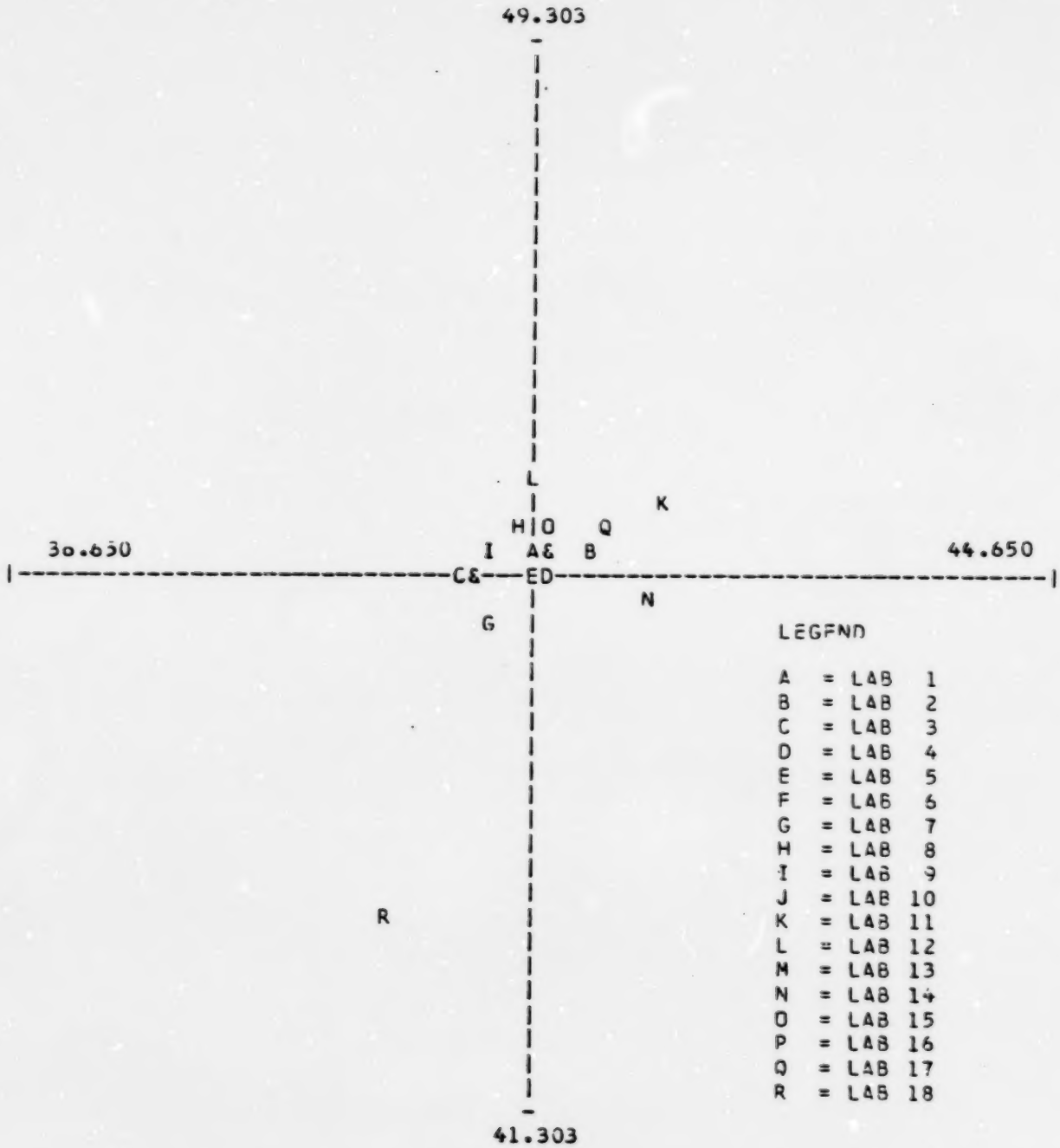
WITHIN-LABORATORY AVERAGES AND STANDARD DEVIATIONS

LAB	AVERAGE	SIGMA
MATERIAL 1		
LAB 1	40.650	0.213
LAB 2	41.150	0.080
LAB 3	40.050	0.072
LAB 4	40.750	0.075
LAB 5	40.650	0.213
LAB 6	40.250	0.215
LAB 7	40.350	0.213
LAB 8	40.500	0.284
LAB 9	40.300	0.285
LAB 10	40.600	0.022
LAB 11	41.650	0.496
LAB 12	40.600	0.038
LAB 13	40.150	0.075
LAB 14	41.600	0.143
LAB 15	40.750	0.213
LAB 16	40.750	0.354
LAB 17	41.200	0.425
LAB 18	39.550	0.354
MATERIAL 2		
LAB 1	45.400	0.022
LAB 2	45.400	0.022
LAB 3	45.350	0.078
LAB 4	45.300	0.146
LAB 5	45.350	0.078
LAB 6	45.350	0.078
LAB 7	44.950	0.073
LAB 8	45.650	0.070
LAB 9	45.400	0.424
LAB 10	45.450	0.072
LAB 11	45.950	0.081
LAB 12	46.100	0.147
LAB 13	45.300	0.000
LAB 14	45.050	0.919
LAB 15	45.700	0.284
LAB 16	45.500	0.143
LAB 17	45.600	0.144
LAB 18	42.650	1.627

TEST 46: HOT MIX,PREP. SAMP.,% AGGREG. RETAINED ON THE 4.75MM SIEVE BY MASS
TEST PERIOD: 81

SCATTER PLOT ANALYSIS
SCALE: 0.444 UNITS=1 CM

HORIZONTAL AXIS: MATERIAL 1
VERTICAL AXIS: MATERIAL 2



LEGEND

A	= LAB	1
B	= LAB	2
C	= LAB	3
D	= LAB	4
E	= LAB	5
F	= LAB	6
G	= LAB	7
H	= LAB	8
I	= LAB	9
J	= LAB	10
K	= LAB	11
L	= LAB	12
M	= LAB	13
N	= LAB	14
O	= LAB	15
P	= LAB	16
Q	= LAB	17
R	= LAB	18

	MATERIAL 1	MATERIAL 2
MEAN	40.650	45.303
STANDARD DEVIATION	0.553	0.782
STANDARD ERROR OF THE MEAN	0.092	0.130

TEST 49: HOT MIX,PREP. SAMP.,% AGGREG. RETAINED ON THE 2.36MM SIEVE
TEST PERIOD: 81

TABLE OF TEST RESULTS

	MATERIAL 1		MATERIAL 2	
LAB 1 OPERATOR 1	49.800	49.700	53.800	53.800
LAB 2 OPERATOR 1	51.400	50.100	53.500	54.400
LAB 3 OPERATOR 1	50.600	49.700	53.100	54.600
LAB 4 OPERATOR 1	48.900	49.400	54.300	51.900
LAB 5 OPERATOR 1	50.000	50.000	53.000	53.000
LAB 6 OPERATOR 1	50.000	49.000	52.000	53.000
LAB 7 OPERATOR 1	49.100	48.200	53.200	53.300
LAB 8 OPERATOR 1	49.500	50.100	53.800	54.200
LAB 9 OPERATOR 1	49.300	50.000	52.500	52.100
LAB 10 OPERATOR 1	49.700	50.100	54.000	54.100
LAB 11 OPERATOR 1	48.000	51.600	55.500	53.600
LAB 12 OPERATOR 1	49.300	50.000	54.000	53.900
LAB 13 OPERATOR 1	50.600	48.400	52.800	53.100
LAB 14 OPERATOR 1	48.900	50.800	53.000	54.200
LAB 15 OPERATOR 1	50.300	49.700	54.500	55.000
LAB 16 OPERATOR 1	50.200	51.300	53.300	53.500
LAB 17 OPERATOR 1	50.000	50.200	53.200	52.900
LAB 18 OPERATOR 1	49.200	51.000	51.600	52.300
RANGES	5.000		3.900	

TEST #9: HOT MIX,PREP. SAMP.,% AGGREG. RETAINED ON THE 2.36MM SIEVE
TEST PERIOD: 81

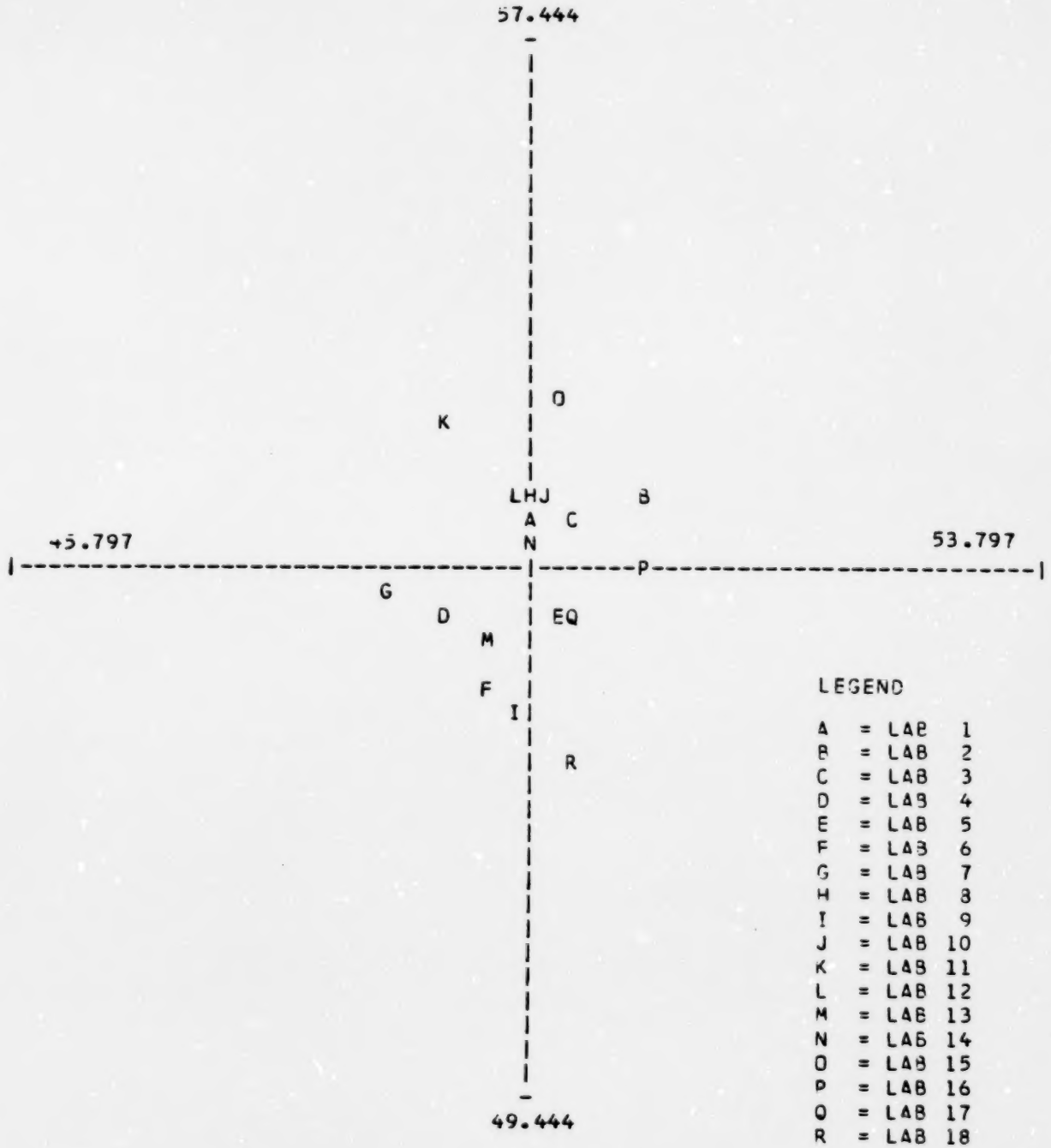
WITHIN-LABORATORY AVERAGES AND STANDARD DEVIATIONS

LAB	AVERAGE	SIGMA
MATERIAL 1		
LAB 1	49.750	0.072
LAB 2	50.750	0.919
LAB 3	50.150	0.637
LAB 4	49.150	0.354
LAB 5	50.000	0.000
LAB 6	49.500	0.707
LAB 7	48.650	0.637
LAB 8	49.800	0.425
LAB 9	49.650	0.497
LAB 10	49.900	0.285
LAB 11	49.100	3.536
LAB 12	49.650	0.497
LAB 13	49.500	1.556
LAB 14	49.850	1.343
LAB 15	50.000	0.424
LAB 16	50.750	0.778
LAB 17	50.100	0.141
LAB 18	50.100	1.273
MATERIAL 2		
LAB 1	53.800	0.000
LAB 2	53.950	0.637
LAB 3	53.850	1.061
LAB 4	53.100	1.697
LAB 5	53.000	0.000
LAB 6	52.500	0.707
LAB 7	53.250	0.072
LAB 8	54.000	0.283
LAB 9	52.300	0.284
LAB 10	54.050	0.078
LAB 11	54.550	1.344
LAB 12	53.950	0.076
LAB 13	52.950	0.213
LAB 14	53.600	0.850
LAB 15	54.750	0.354
LAB 16	53.400	0.147
LAB 17	53.050	0.213
LAB 18	51.950	0.496

TEST 49: HOT MIX,PREP. SAMP.,% AGGREG. RETAINED ON THE 2.36MM SIEVE BY MASS
TEST PERIOD: 81

SCATTER PLOT ANALYSIS
SCALE: 0.444 UNITS=1 CM

HORIZONTAL AXIS: MATERIAL 1
VERTICAL AXIS: MATERIAL 2



LEGEND

A	= LAB	1
B	= LAB	2
C	= LAB	3
D	= LAB	4
E	= LAB	5
F	= LAB	6
G	= LAB	7
H	= LAB	8
I	= LAB	9
J	= LAB	10
K	= LAB	11
L	= LAB	12
M	= LAB	13
N	= LAB	14
O	= LAB	15
P	= LAB	16
Q	= LAB	17
R	= LAB	18

	MATERIAL 1	MATERIAL 2
MEAN	49.797	53.444
STANDARD DEVIATION	0.949	0.884
STANDARD ERROR OF THE MEAN	0.158	0.147

TEST 50: HOT MIX,PREP. SAMP.,% AGGREG. RETAINED ON THE 1.18MM SIEVE
TEST PERIOD: 81

TABLE OF TEST RESULTS

	MATERIAL 1		MATERIAL 2	
LAB 1 OPERATOR 1	59.000	59.400	62.000	62.900
LAB 2 OPERATOR 1	60.000	58.800	61.400	62.800
LAB 3 OPERATOR 1	59.800	58.800	60.900	63.000
LAB 4 OPERATOR 1	57.200	58.200	62.700	59.300
LAB 5 OPERATOR 1	58.000	59.000	60.000	60.000
LAB 6 OPERATOR 1	60.000	57.000	60.000	61.000
LAB 7 OPERATOR 1	57.400	56.200	61.600	61.600
LAB 8 OPERATOR 1	58.100	58.100	61.700	63.000
LAB 9 OPERATOR 1	61.700	60.600	63.200	62.600
LAB 10 OPERATOR 1	58.400	58.600	63.400	62.000
LAB 11 OPERATOR 1	60.900	59.800	63.800	60.900
LAB 12 OPERATOR 1	58.200	58.800	62.200	62.800
LAB 13 OPERATOR 1	58.800	58.600	60.500	60.200
LAB 14 OPERATOR 1	57.100	59.900	62.000	63.200
LAB 15 OPERATOR 1	59.400	57.000	62.600	63.600
LAB 16 OPERATOR 1	59.100	61.500	61.200	61.800
LAB 17 OPERATOR 1	59.000	59.000	60.900	60.900
LAB 18 OPERATOR 1	59.000	61.700	61.300	60.600
RANGES	5.500		4.600	

TEST 50: HOT MIX,PREP. SAMP.,% AGGREG. RETAINED ON THE 1.18MM SIEVE
TEST PERIOD: 81

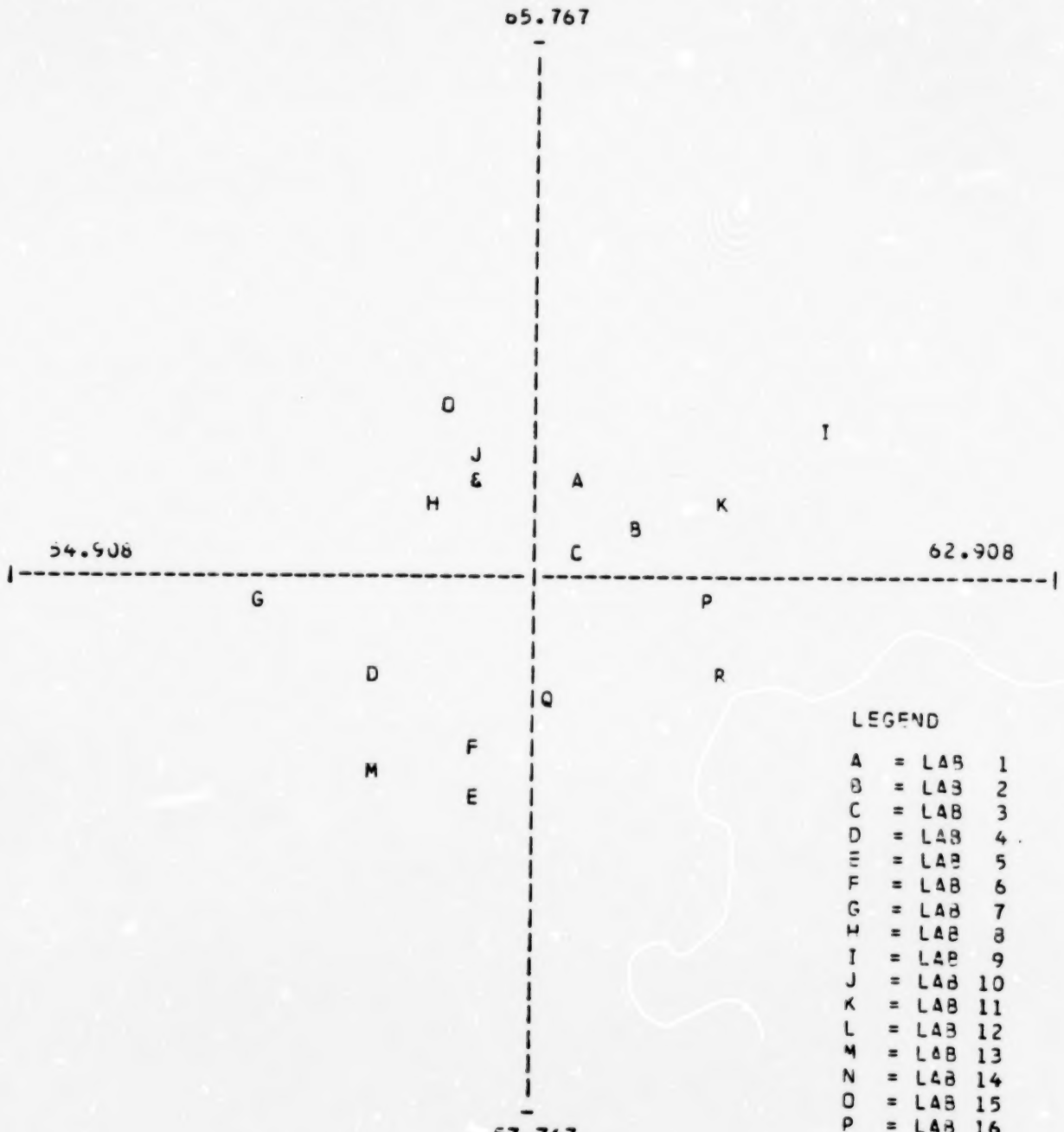
WITHIN-LABORATORY AVERAGES AND STANDARD DEVIATIONS

LAB	AVERAGE	SIGMA
MATERIAL 1		
LAB 1	59.200	0.286
LAB 2	59.700	1.273
LAB 3	59.300	0.707
LAB 4	57.700	0.708
LAB 5	58.500	0.707
LAB 6	58.500	2.121
LAB 7	58.800	0.849
LAB 8	58.100	0.031
LAB 9	61.150	0.776
LAB 10	58.500	0.141
LAB 11	60.350	0.778
LAB 12	58.500	0.424
LAB 13	57.700	1.556
LAB 14	58.500	1.980
LAB 15	58.200	1.697
LAB 16	60.300	1.697
LAB 17	59.000	0.000
LAB 18	60.350	1.909
MATERIAL 2		
LAB 1	62.450	0.637
LAB 2	62.100	0.991
LAB 3	61.950	1.485
LAB 4	61.000	2.404
LAB 5	60.000	0.000
LAB 6	60.500	0.707
LAB 7	61.600	0.022
LAB 8	62.350	0.920
LAB 9	62.900	0.424
LAB 10	62.700	0.990
LAB 11	62.350	2.051
LAB 12	62.500	0.424
LAB 13	60.350	0.213
LAB 14	62.600	0.849
LAB 15	63.100	0.708
LAB 16	61.500	0.424
LAB 17	60.900	0.031
LAB 18	60.950	0.497

TEST 50: HOT MIX,PREP. SAMP.,% AGGREG. RETAINED ON THE 1.18MM SIEVE BY MASS
TEST PERIOD: 81

SCATTER PLOT ANALYSIS
SCALE: 0.444 UNITS=1 CM

HORIZONTAL AXIS: MATERIAL 1
VERTICAL AXIS: MATERIAL 2



LEGEND

A	=	LAB 1
B	=	LAB 2
C	=	LAB 3
D	=	LAB 4
E	=	LAB 5
F	=	LAB 6
G	=	LAB 7
H	=	LAB 8
I	=	LAB 9
J	=	LAB 10
K	=	LAB 11
L	=	LAB 12
M	=	LAB 13
N	=	LAB 14
O	=	LAB 15
P	=	LAB 16
Q	=	LAB 17
R	=	LAB 18

	MATERIAL 1	MATERIAL 2
MEAN	58.908	61.767
STANDARD DEVIATION	1.395	1.175
STANDARD ERROR OF THE MEAN	0.233	0.196

TEST 51: HOT MIX,PREP. SAMP.,% AGGREG. RETAINED ON THE 600UM SIEVE
TEST PERIOD: 81

TABLE OF TEST RESULTS

	MATERIAL 1		MATERIAL 2	
LAB 1 OPERATOR 1	72.500	73.100	73.800	75.200
LAB 2 OPERATOR 1	73.300	71.700	73.400	74.400
LAB 3 OPERATOR 1	73.200	72.200	72.800	74.800
LAB 4 OPERATOR 1	71.700	71.500	75.900	73.700
LAB 5 OPERATOR 1	72.000	72.000	72.000	72.000
LAB 6 OPERATOR 1	73.000	70.000	71.000	73.000
LAB 7 OPERATOR 1	71.200	69.300	73.900	73.200
LAB 8 OPERATOR 1	72.000	71.700	73.700	75.000
LAB 9 OPERATOR 1	75.800	74.100	75.600	75.500
LAB 10 OPERATOR 1	72.100	72.400	77.600	74.400
LAB 11 OPERATOR 1	76.200	74.100	77.700	74.400
LAB 12 OPERATOR 1	70.700	71.500	73.500	74.300
LAB 13 OPERATOR 1	71.600	70.200	72.500	71.600
LAB 14 OPERATOR 1	70.300	72.700	74.400	75.500
LAB 15 OPERATOR 1	72.600	68.700	73.900	75.000
LAB 16 OPERATOR 1	73.100	75.600	73.200	74.500
LAB 17 OPERATOR 1	73.600	73.000	73.400	73.500
LAB 18 OPERATOR 1	71.800	74.400	73.200	72.000
RANGES	7.500		7.000	

TEST 51: HOT MIX,PREP. SAMP.,% AGGREG. RETAINED ON THE 600UM SIEVE
TEST PERIOD: 81

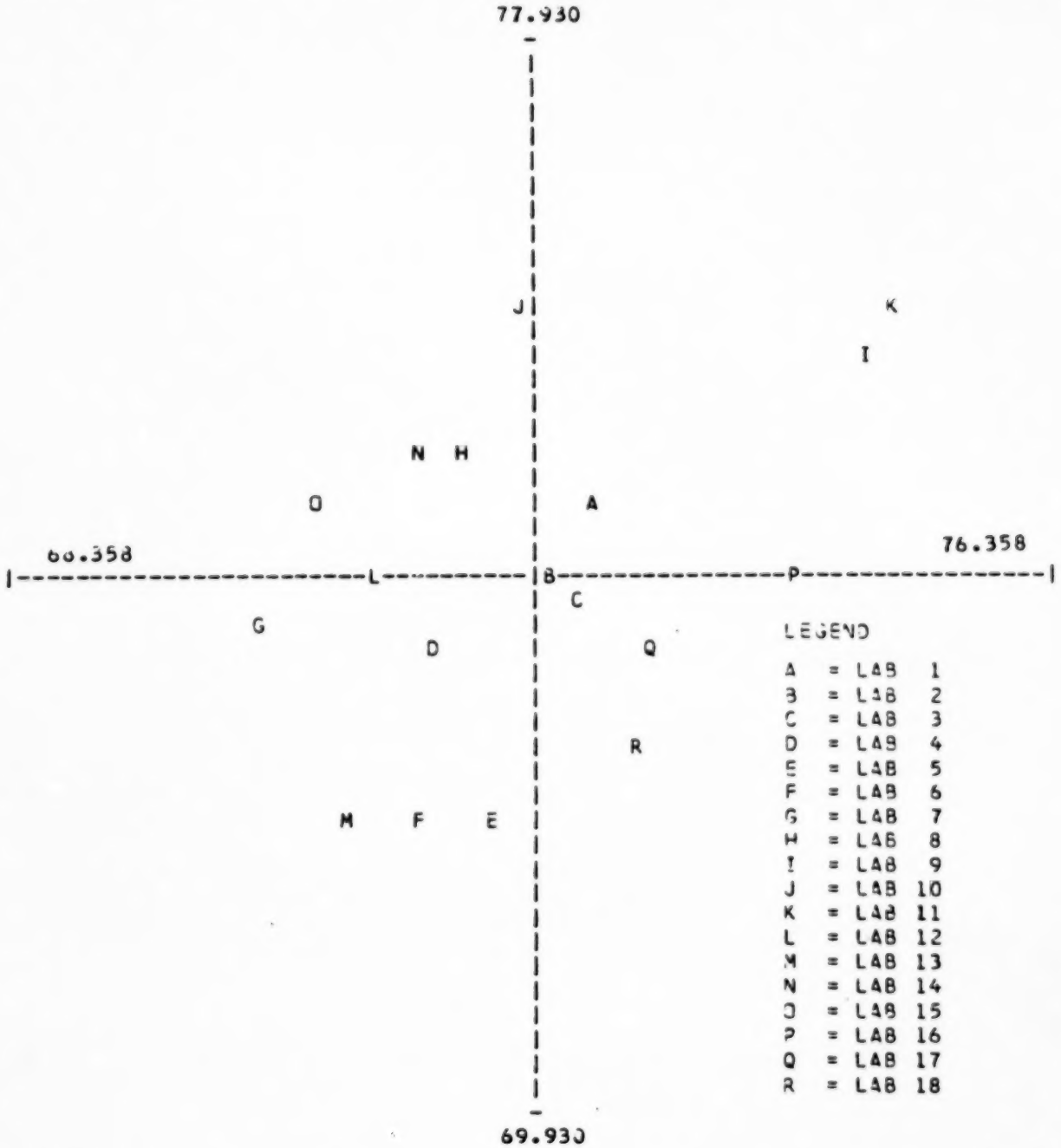
WITHIN-LABORATORY AVERAGES AND STANDARD DEVIATIONS

LAB	AVERAGE	SIGMA
MATERIAL 1		
LAB 1	72.600	0.422
LAB 2	72.500	1.130
LAB 3	72.700	0.704
LAB 4	71.600	0.133
LAB 5	72.000	0.000
LAB 6	71.500	2.121
LAB 7	70.250	1.343
LAB 8	71.850	0.207
LAB 9	74.950	1.202
LAB 10	72.250	0.207
LAB 11	75.150	1.464
LAB 12	71.100	0.566
LAB 13	70.900	0.990
LAB 14	71.500	1.697
LAB 15	70.650	2.757
LAB 16	74.350	1.766
LAB 17	73.300	0.424
LAB 18	73.100	1.837
MATERIAL 2		
LAB 1	74.500	0.990
LAB 2	73.900	0.704
LAB 3	73.800	1.413
LAB 4	73.300	3.677
LAB 5	72.000	0.000
LAB 6	72.000	1.414
LAB 7	73.550	0.492
LAB 8	74.850	1.626
LAB 9	75.550	0.044
LAB 10	76.000	2.262
LAB 11	76.050	2.333
LAB 12	73.900	0.563
LAB 13	72.050	0.637
LAB 14	74.950	0.776
LAB 15	74.450	0.777
LAB 16	73.850	0.919
LAB 17	73.450	0.077
LAB 18	72.600	0.848

TEST 51: HOT MIX,PREP. SAMP.,% AGGREG. RETAINED ON THE 6GOUM SIEVE BY MASS
TEST PERIOD: 01

SCATTER PLOT ANALYSIS
SCALE: 0.444 UNITS=1 CM

HORIZONTAL AXIS: MATERIAL 1
VERTICAL AXIS: MATERIAL 2



	MATERIAL 1	MATERIAL 2
MEAN	72.358	73.930
STANDARD DEVIATION	1.673	1.610
STANDARD ERROR OF THE MEAN	0.279	0.268

TEST 52: HOT MIX,PREP. SAMP.,% AGGREG. RETAINED ON THE 300UM SIEVE
TEST PERIOD: 81

TABLE OF TEST RESULTS

	MATERIAL 1		MATERIAL 2	
LAB 1 OPERATOR 1	87.500	87.800	87.500	88.400
LAB 2 OPERATOR 1	86.100	86.600	87.600	87.900
LAB 3 OPERATOR 1	89.100	87.700	87.300	88.900
LAB 4 OPERATOR 1	87.500	87.900	89.400	86.000
LAB 5 OPERATOR 1	87.000	87.000	87.000	87.000
LAB 6 OPERATOR 1	89.000	87.000	86.000	87.000
LAB 7 OPERATOR 1	87.100	86.300	87.700	87.600
LAB 8 OPERATOR 1	86.000	86.800	86.900	89.000
LAB 9 OPERATOR 1	89.000	89.200	88.100	88.700
LAB 10 OPERATOR 1	87.400	87.500	89.500	88.100
LAB 11 OPERATOR 1	89.500	88.300	90.700	87.400
LAB 12 OPERATOR 1	86.200	87.100	87.400	87.900
LAB 13 OPERATOR 1	86.200	85.400	86.600	85.400
LAB 14 OPERATOR 1	85.600	86.100	87.400	88.000
LAB 15 OPERATOR 1	87.700	85.500	87.700	88.100
LAB 16 OPERATOR 1	88.300	85.400	87.400	88.400
LAB 17 OPERATOR 1	88.300	87.600	87.000	87.000
LAB 18 OPERATOR 1	88.700	89.500	88.800	87.900
RANGES	4.100		5.300	

TEST 52: HOT MIX,PREP. SAMP.,% AGGREG. RETAINED ON THE 300UM SIEVE
TEST PERIOD: 01

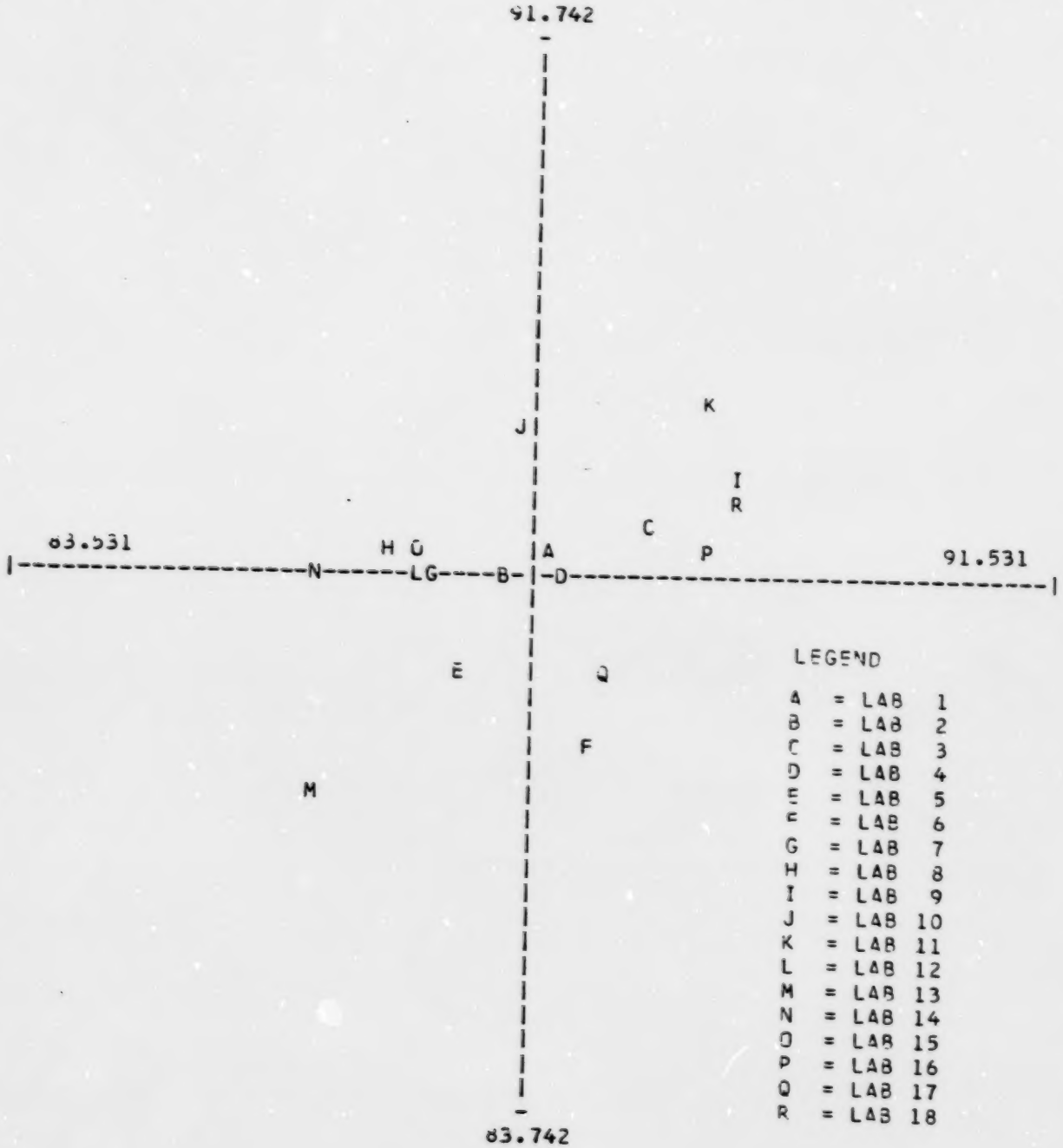
WITHIN-LABORATORY AVERAGES AND STANDARD DEVIATIONS

LAB	AVERAGE	SIGMA
MATERIAL 1		
LAB 1	87.650	0.212
LAB 2	87.350	1.058
LAB 3	88.400	0.988
LAB 4	87.700	0.280
LAB 5	87.000	0.000
LAB 6	88.000	1.414
LAB 7	86.700	0.564
LAB 8	86.400	0.564
LAB 9	89.100	0.133
LAB 10	87.450	0.063
LAB 11	88.900	0.849
LAB 12	86.650	0.634
LAB 13	85.800	0.563
LAB 14	85.850	0.348
LAB 15	86.600	1.556
LAB 16	88.850	0.776
LAB 17	88.050	0.637
LAB 18	89.100	0.564
MATERIAL 2		
LAB 1	87.950	0.637
LAB 2	87.750	0.207
LAB 3	88.100	1.130
LAB 4	87.700	2.404
LAB 5	87.000	0.000
LAB 6	86.500	0.707
LAB 7	87.650	0.077
LAB 8	87.950	1.484
LAB 9	88.400	0.419
LAB 10	88.800	0.989
LAB 11	89.050	2.333
LAB 12	87.650	0.351
LAB 13	86.000	0.845
LAB 14	87.700	0.424
LAB 15	87.900	0.280
LAB 16	87.900	0.707
LAB 17	87.000	0.000
LAB 18	86.350	0.634

TEST 52: HOT MIX,PREP. SAMP.,& AGGREG. RETAINED ON THE 300UM SIEVE BY MASS
TEST PERIOD: 81

SCATTER PLOT ANALYSIS
SCALE: 0.444 UNITS=1 CM

HORIZONTAL AXIS: MATERIAL 1
VERTICAL AXIS: MATERIAL 2



LEGEND

A	= LAB	1
B	= LAB	2
C	= LAB	3
D	= LAB	4
E	= LAB	5
F	= LAB	6
G	= LAB	7
H	= LAB	8
I	= LAB	9
J	= LAB	10
K	= LAB	11
L	= LAB	12
M	= LAB	13
N	= LAB	14
O	= LAB	15
P	= LAB	16
Q	= LAB	17
R	= LAB	18

	MATERIAL 1	MATERIAL 2
MEAN	87.531	87.742
STANDARD DEVIATION	1.168	1.043
STANDARD ERROR OF THE MEAN	0.198	0.174

TEST 53: HOT MIX,PREP. SAMP.,% AGGREG. RETAINED ON THE 150UM SIEVE
TEST PERIOD: 81

TABLE OF TEST RESULTS

	MATERIAL 1		MATERIAL 2	
LAB 1 OPERATOR 1	94.200	94.400	93.900	94.300
LAB 2 OPERATOR 1	94.000	93.300	93.500	93.500
LAB 3 OPERATOR 1	94.500	93.600	93.100	94.500
LAB 4 OPERATOR 1	94.600	94.100	95.300	92.600
LAB 5 OPERATOR 1	94.000	94.000	93.000	94.000
LAB 6 OPERATOR 1	94.000	93.000	93.000	93.000
LAB 7 OPERATOR 1	93.900	93.500	93.400	93.200
LAB 8 OPERATOR 1	93.000	93.800	93.400	94.400
LAB 9 OPERATOR 1	93.900	94.900	93.800	94.000
LAB 10 OPERATOR 1	94.600	93.600	94.300	94.500
LAB 11 OPERATOR 1	94.500	94.300	95.700	94.800
LAB 12 OPERATOR 1	92.800	93.700	93.500	93.600
LAB 13 OPERATOR 1	94.200	93.200	94.400	93.700
LAB 14 OPERATOR 1	93.000	92.800	92.900	93.200
LAB 15 OPERATOR 1	93.900	93.100	93.400	93.700
LAB 16 OPERATOR 1	94.500	94.500	93.900	94.000
LAB 17 OPERATOR 1	94.900	94.100	93.000	94.600
LAB 18 OPERATOR 1	94.900	94.500	94.300	94.300
RANGES	2.100		3.100	

TEST 33: HOT MIX,PREP. SAMP.,% AGGREG. RETAINED ON THE 150UM SIEVE
TEST PERIOD: 81

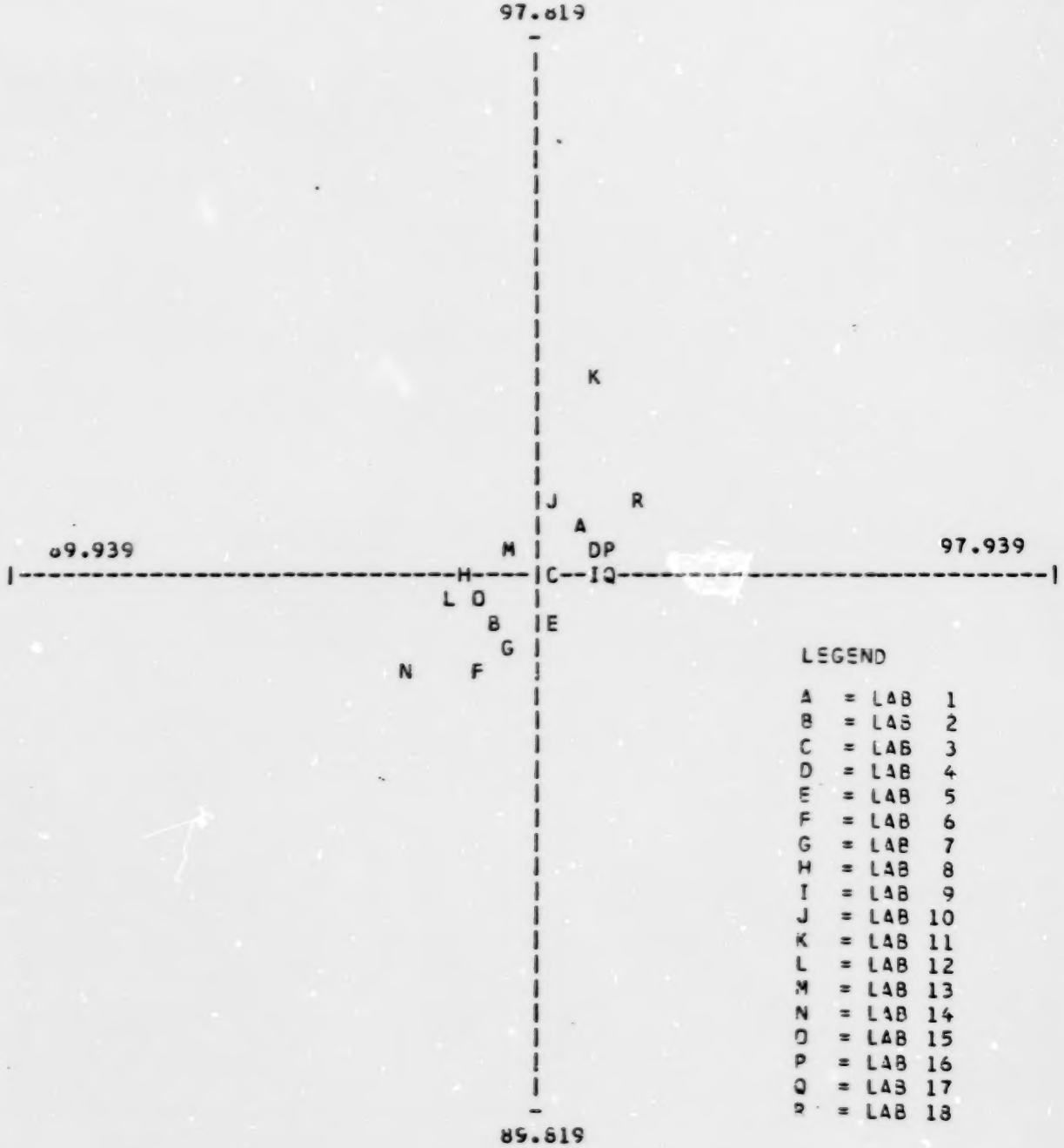
WITHIN-LABORATORY AVERAGES AND STANDARD DEVIATIONS

LAB	AVERAGE	SIGMA
MATERIAL 1		
LAB 1	94.300	0.125
LAB 2	93.650	0.494
LAB 3	94.050	0.636
LAB 4	94.350	0.348
LAB 5	94.000	0.000
LAB 6	93.500	0.707
LAB 7	93.700	0.283
LAB 8	93.400	0.566
LAB 9	94.400	0.706
LAB 10	94.100	0.706
LAB 11	94.400	0.133
LAB 12	93.250	0.634
LAB 13	93.700	0.706
LAB 14	92.900	0.140
LAB 15	93.500	0.563
LAB 16	94.500	0.000
LAB 17	94.500	0.563
LAB 18	94.700	0.283
MATERIAL 2		
LAB 1	94.100	0.276
LAB 2	93.500	0.000
LAB 3	93.800	0.989
LAB 4	93.950	1.909
LAB 5	93.500	0.707
LAB 6	93.000	0.000
LAB 7	93.300	0.140
LAB 8	93.900	0.706
LAB 9	93.800	0.283
LAB 10	94.400	0.133
LAB 11	95.250	0.634
LAB 12	93.550	0.063
LAB 13	94.050	0.490
LAB 14	93.050	0.207
LAB 15	93.550	0.207
LAB 16	93.950	0.063
LAB 17	93.800	1.131
LAB 18	94.300	0.077

TEST 55: HOT MIX,PREP. SAMP.,% AGGREG. RETAINED ON THE 150UM SIEVE BY MASS
TEST PERIOD: 81

SCATTER PLOT ANALYSIS
SCALE: 0.444 UNITS=1 CM

HORIZONTAL AXIS: MATERIAL 1
VERTICAL AXIS: MATERIAL 2



LEGEND

A	= LAB	1
B	= LAB	2
C	= LAB	3
D	= LAB	4
E	= LAB	5
F	= LAB	6
G	= LAB	7
H	= LAB	8
I	= LAB	9
J	= LAB	10
K	= LAB	11
L	= LAB	12
M	= LAB	13
N	= LAB	14
O	= LAB	15
P	= LAB	16
Q	= LAB	17
R	= LAB	18

	MATERIAL 1	MATERIAL 2
MEAN	93.939	93.819
STANDARD DEVIATION	0.618	0.701
STANDARD ERROR OF THE MEAN	0.103	0.117

TEST 54: HOT MIX,PREP. SAMP.,% AGGREG. RETAINED ON THE 75UM SIEVE
TEST PERIOD: 81

TABLE OF TEST RESULTS

	MATERIAL 1		MATERIAL 2	
LAB 1 OPERATOR 1	96.500	96.900	96.200	96.600
LAB 2 OPERATOR 1	96.300	96.400	95.900	95.900
LAB 3 OPERATOR 1	96.800	96.100	95.600	96.700
LAB 4 OPERATOR 1	97.400	97.000	97.600	96.200
LAB 5 OPERATOR 1	96.700	96.500	96.100	96.100
LAB 6 OPERATOR 1	96.200	96.100	95.800	95.900
LAB 7 OPERATOR 1	97.100	97.000	96.000	96.000
LAB 8 OPERATOR 1	96.300	96.600	96.300	96.400
LAB 9 OPERATOR 1	95.900	97.200	96.200	96.400
LAB 10 OPERATOR 1	97.200	96.600	97.600	97.400
LAB 11 OPERATOR 1	97.700	98.900	99.500	99.400
LAB 12 OPERATOR 1	96.100	96.300	96.400	96.300
LAB 13 OPERATOR 1	96.300	96.400	97.700	97.000
LAB 14 OPERATOR 1	94.500	93.100	95.500	93.500
LAB 15 OPERATOR 1	97.200	96.400	96.100	97.000
LAB 16 OPERATOR 1	98.400	97.300	98.200	97.900
LAB 17 OPERATOR 1	98.000	97.300	96.000	97.900
LAB 18 OPERATOR 1	97.400	96.500	98.600	97.100
RANGES	5.800		6.000	

TEST 54: HOT MIX,PREP. SAMP.,% AGGREG. RETAINED ON THE 75UM SIEVE
TEST PERIOD: 81

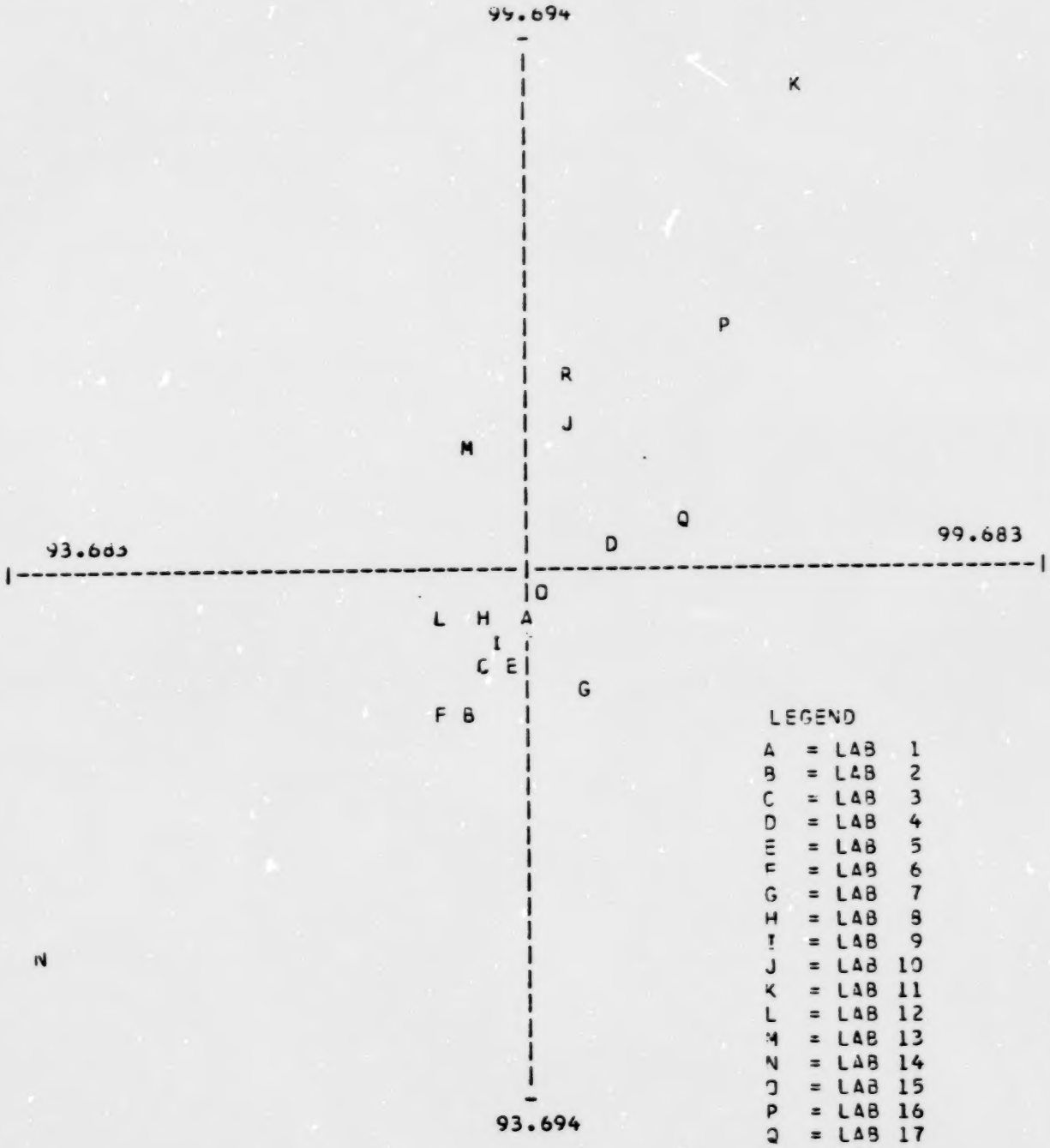
WITHIN-LABORATORY AVERAGES AND STANDARD DEVIATIONS

LAB	AVERAGE	SIGMA
MATERIAL 1		
LAB 1	96.700	0.280
LAB 2	96.350	0.063
LAB 3	96.450	0.492
LAB 4	97.200	0.283
LAB 5	96.600	0.133
LAB 6	96.150	0.044
LAB 7	97.050	0.063
LAB 8	96.450	0.207
LAB 9	96.550	0.917
LAB 10	96.900	0.417
LAB 11	98.300	0.848
LAB 12	96.200	0.140
LAB 13	96.350	0.063
LAB 14	93.800	0.989
LAB 15	96.800	0.563
LAB 16	97.850	0.777
LAB 17	97.650	0.494
LAB 18	96.950	0.636
MATERIAL 2		
LAB 1	96.400	0.276
LAB 2	95.900	0.000
LAB 3	96.150	0.774
LAB 4	96.900	0.989
LAB 5	96.100	0.044
LAB 6	95.850	0.063
LAB 7	96.000	0.000
LAB 8	96.350	0.063
LAB 9	96.300	0.133
LAB 10	97.500	0.140
LAB 11	99.450	0.044
LAB 12	96.350	0.063
LAB 13	97.350	0.496
LAB 14	94.500	1.414
LAB 15	96.550	0.636
LAB 16	98.050	0.207
LAB 17	96.950	1.343
LAB 18	97.850	1.060

TEST 54: HOT MIX,PREP. SAMP.,% AGGREG. RETAINED ON THE 75UM SIEVE BY MASS
TEST PERIOD: 81

SCATTER PLOT ANALYSIS
SCALE: 0.333 UNITS=1 CM

HORIZONTAL AXIS: MATERIAL 1
VERTICAL AXIS: MATERIAL 2



LEGEND

A	=	LAB 1
B	=	LAB 2
C	=	LAB 3
D	=	LAB 4
E	=	LAB 5
F	=	LAB 6
G	=	LAB 7
H	=	LAB 8
I	=	LAB 9
J	=	LAB 10
K	=	LAB 11
L	=	LAB 12
M	=	LAB 13
N	=	LAB 14
O	=	LAB 15
P	=	LAB 16
Q	=	LAB 17
R	=	LAB 18

	MATERIAL 1	MATERIAL 2
MEAN	96.683	96.694
STANDARD DEVIATION	0.987	1.156
STANDARD ERROR OF THE MEAN	0.164	0.193

Tests 2, 4, 24 7 25

Coarse Aggregate Bulk Relative Density and Absorption

Fine Aggregate Bulk Relative Density and Absorption

Method: MTC LS-604 / LS-605

Reference: ASTM C127-80 / C128-79

These aggregate tests determine the bulk relative densities of the coarse and fine aggregates. These bulk relative densities are used in the calculation of the volume of voids in mineral aggregate or V.M.A. Since only a single determination was made, this figure was duplicated to give two entries for each material and each laboratory.

The scatter diagrams visually point out the wide variation in bulk relative densities which will also affect a wider variation in VMA test 28.

TEST 2: RELATIVE DENSITY(COARSE AGGREGATE-BULK)
TEST PERIOD: 81

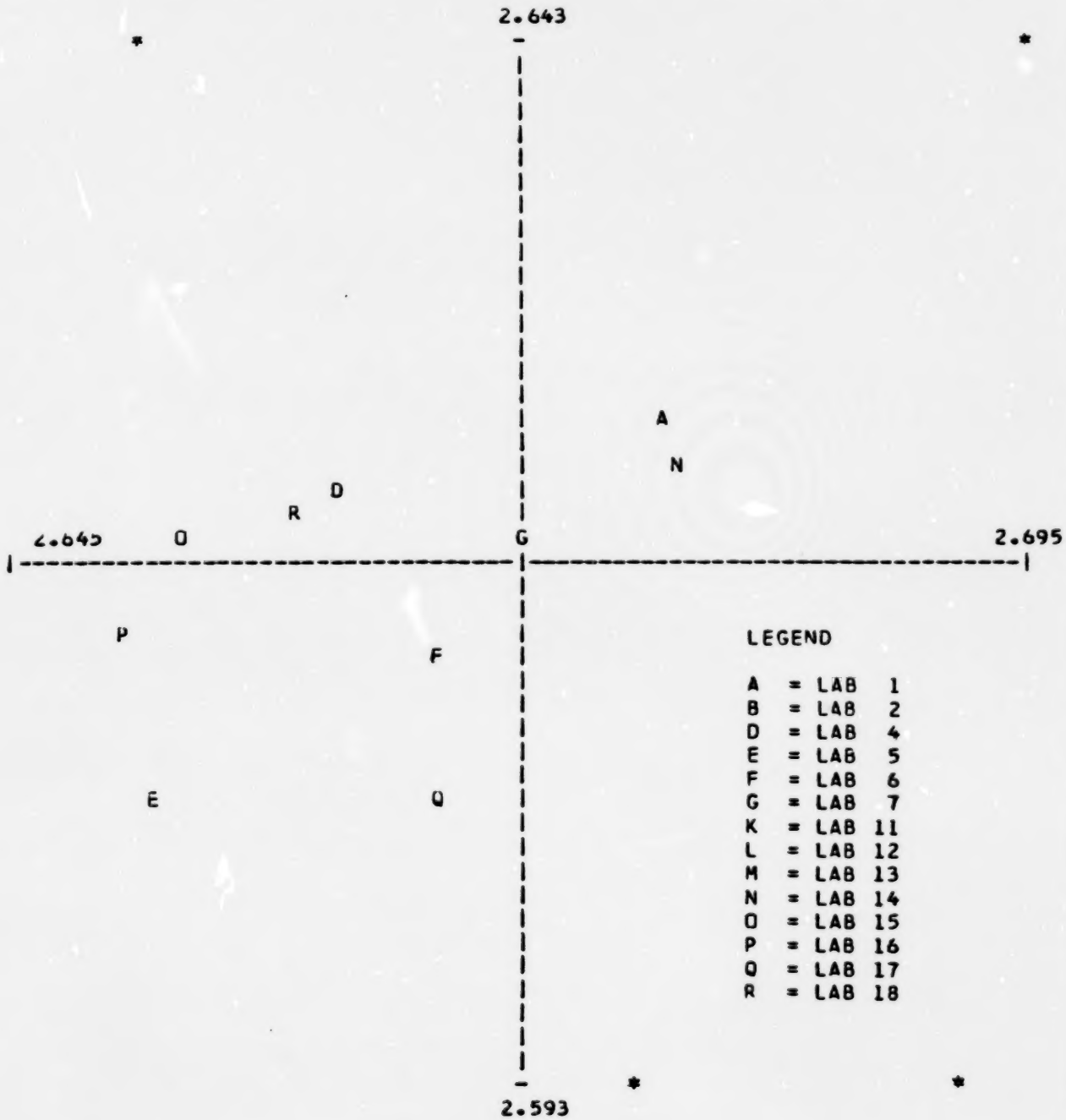
TABLE OF TEST RESULTS

	MATERIAL 1		MATERIAL 2	
LAB 1 OPERATOR 1	2.677	2.677	2.625	2.625
LAB 2 OPERATOR 1	2.651	2.651	2.707	2.707
LAB 4 OPERATOR 1	2.661	2.661	2.621	2.621
LAB 5 OPERATOR 1	2.652	2.652	2.606	2.606
LAB 6 OPERATOR 1	2.666	2.666	2.613	2.613
LAB 7 OPERATOR 1	2.670	2.670	2.619	2.619
LAB 11 OPERATOR 1	2.730	2.730	2.670	2.670
LAB 12 OPERATOR 1	2.676	2.676	2.586	2.586
LAB 13 OPERATOR 1	2.692	2.692	2.521	2.521
LAB 14 OPERATOR 1	2.678	2.678	2.623	2.623
LAB 15 OPERATOR 1	2.653	2.653	2.619	2.619
LAB 16 OPERATOR 1	2.650	2.650	2.614	2.614
LAB 17 OPERATOR 1	2.666	2.666	2.606	2.606
LAB 18 OPERATOR 1	2.659	2.659	2.620	2.620
RANGES	0.080		0.186	

TEST 2: RELATIVE DENSITY(COARSE AGGREGATE-BULK)
TEST PERIOD: 81

SCATTER PLOT ANALYSIS
SCALE: 0.003 UNITS=1 CM

HORIZONTAL AXIS: MATERIAL 1
VERTICAL AXIS: MATERIAL 2



LEGEND

A = LAB 1
B = LAB 2
D = LAB 4
E = LAB 5
F = LAB 6
G = LAB 7
K = LAB 11
L = LAB 12
M = LAB 13
N = LAB 14
O = LAB 15
P = LAB 16
Q = LAB 17
R = LAB 18

	MATERIAL 1	MATERIAL 2
MEAN	2.670	2.618
STANDARD DEVIATION	0.021	0.040
STANDARD ERROR OF THE MEAN	0.004	0.008

TEST 4: ABSORPTION(COARSE AGGREGATE)
TEST PERIOD: 81

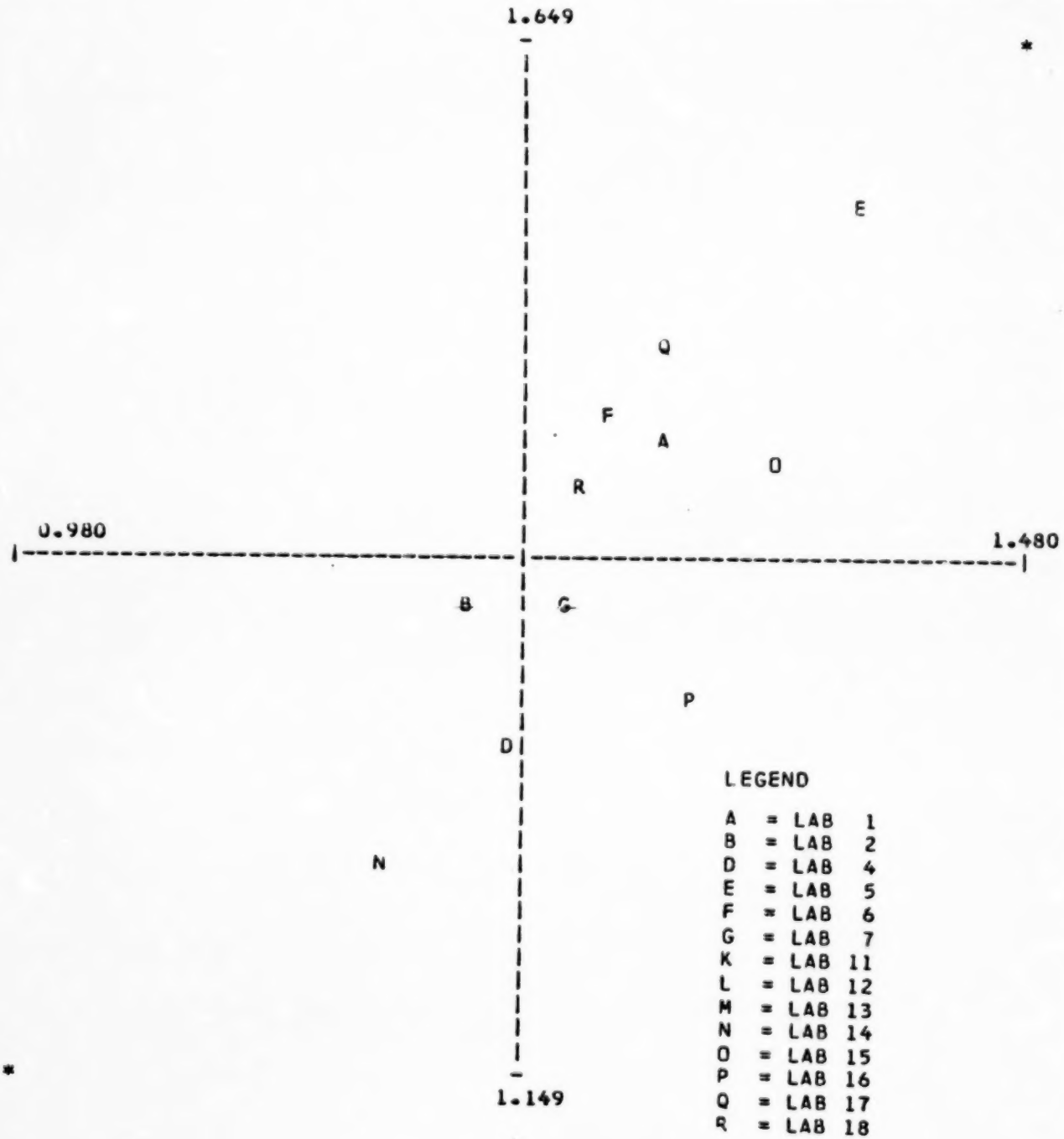
TABLE OF TEST RESULTS

	MATERIAL 1		MATERIAL 2	
LAB 1 OPERATOR 1	1.303	1.303	1.452	1.452
LAB 2 OPERATOR 1	1.205	1.205	1.376	1.376
LAB 4 OPERATOR 1	1.226	1.226	1.307	1.307
LAB 5 OPERATOR 1	1.403	1.403	1.570	1.570
LAB 6 OPERATOR 1	1.271	1.271	1.472	1.472
LAB 7 OPERATOR 1	1.255	1.255	1.371	1.371
LAB 11 OPERATOR 1	0.060	0.060	0.280	0.280
LAB 12 OPERATOR 1	1.608	1.608	1.705	1.705
LAB 13 OPERATOR 1	1.500	1.500	2.100	2.100
LAB 14 OPERATOR 1	1.163	1.163	1.253	1.253
LAB 15 OPERATOR 1	1.360	1.360	1.440	1.440
LAB 16 OPERATOR 1	1.313	1.313	1.328	1.328
LAB 17 OPERATOR 1	1.300	1.300	1.500	1.500
LAB 18 OPERATOR 1	1.260	1.260	1.435	1.435
RANGES	1.548		1.820	

TEST 4: ABSORPTION(COARSE AGGREGATE)
TEST PERIOD: 81

SCATTER PLOT ANALYSIS
SCALE: 0.028 UNITS=1 CM

HORIZONTAL AXIS: MATERIAL 1
VERTICAL AXIS: MATERIAL 2



	MATERIAL 1	MATERIAL 2
MEAN	1.230	1.399
STANDARD DEVIATION	0.350	0.378
STANDARD ERROR OF THE MEAN	0.066	0.071

TEST 24: ABSORPTION(FINE AGGREGATE)
TEST PERIOD: 81

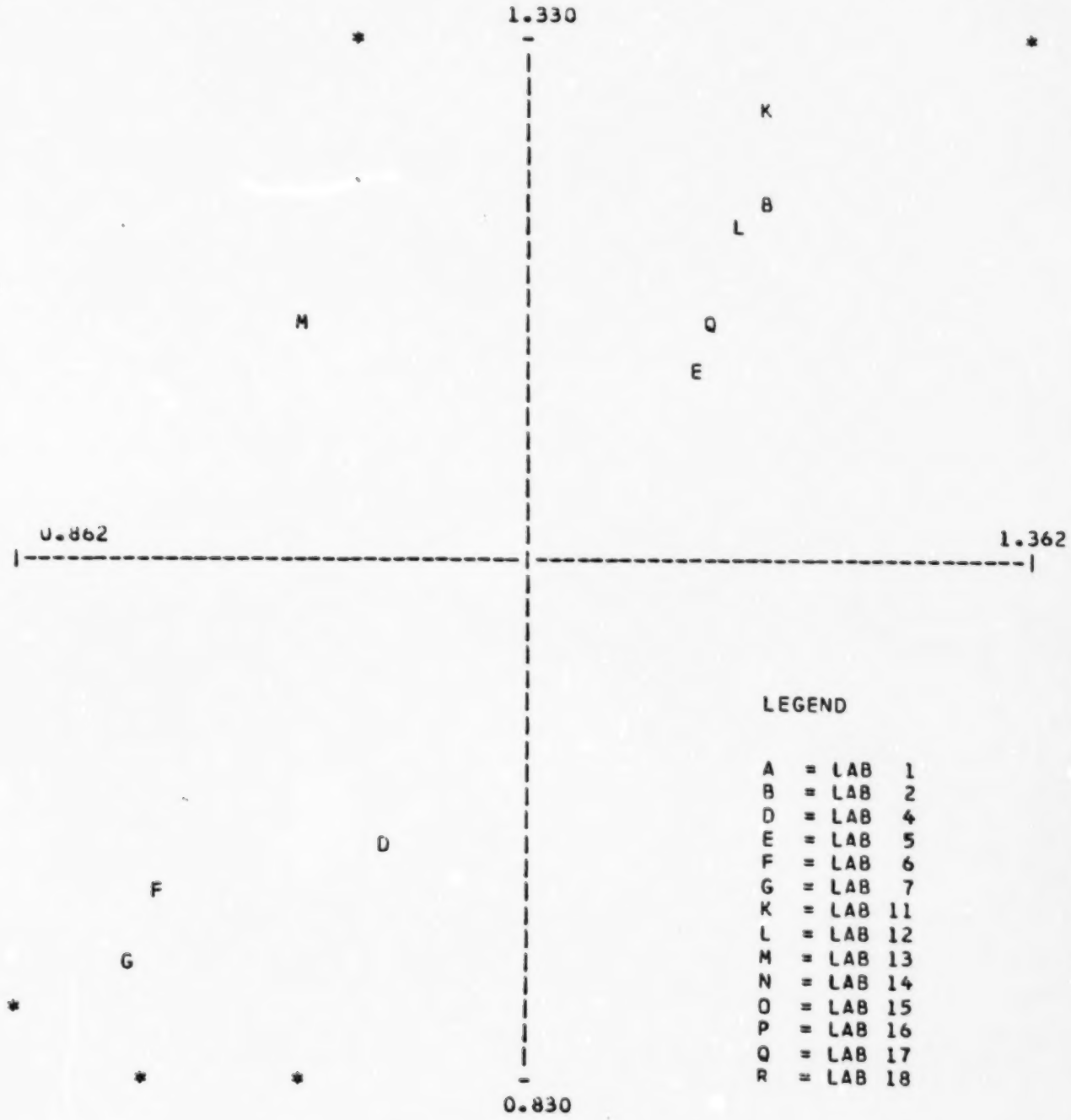
TABLE OF TEST RESULTS

	MATERIAL 1		MATERIAL 2	
LAB 1 OPERATOR 1	0.705	0.705	0.857	0.857
LAB 2 OPERATOR 1	1.235	1.235	1.256	1.256
LAB 4 OPERATOR 1	1.041	1.041	0.938	0.938
LAB 5 OPERATOR 1	1.194	1.194	1.174	1.174
LAB 6 OPERATOR 1	0.928	0.928	0.918	0.918
LAB 7 OPERATOR 1	0.918	0.918	0.877	0.877
LAB 11 OPERATOR 1	1.230	1.230	1.300	1.300
LAB 12 OPERATOR 1	1.217	1.217	1.243	1.243
LAB 13 OPERATOR 1	1.000	1.000	1.200	1.200
LAB 14 OPERATOR 1	1.943	1.943	1.433	1.433
LAB 15 OPERATOR 1	1.030	1.030	1.400	1.400
LAB 16 OPERATOR 1	1.001	1.001	0.743	0.743
LAB 17 OPERATOR 1	1.200	1.200	1.200	1.200
LAB 18 OPERATOR 1	0.923	0.923	0.576	0.576
RANGES	1.238		0.857	

TEST 24: ABSORPTION(FINE AGGREGATE)
TEST PERIOD: 81

SCATTER PLOT ANALYSIS
SCALE: 0.026 UNITS=1 CM

HORIZONTAL AXIS: MATERIAL 1
VERTICAL AXIS: MATERIAL 2



	MATERIAL 1	MATERIAL 2
MEAN	1.112	1.080
STANDARD DEVIATION	0.280	0.255
STANDARD ERROR OF THE MEAN	0.053	0.048

TEST 25: RELATIVE DENSITY(FINE AGGREGATE-BULK)
TEST PERIOD: 81

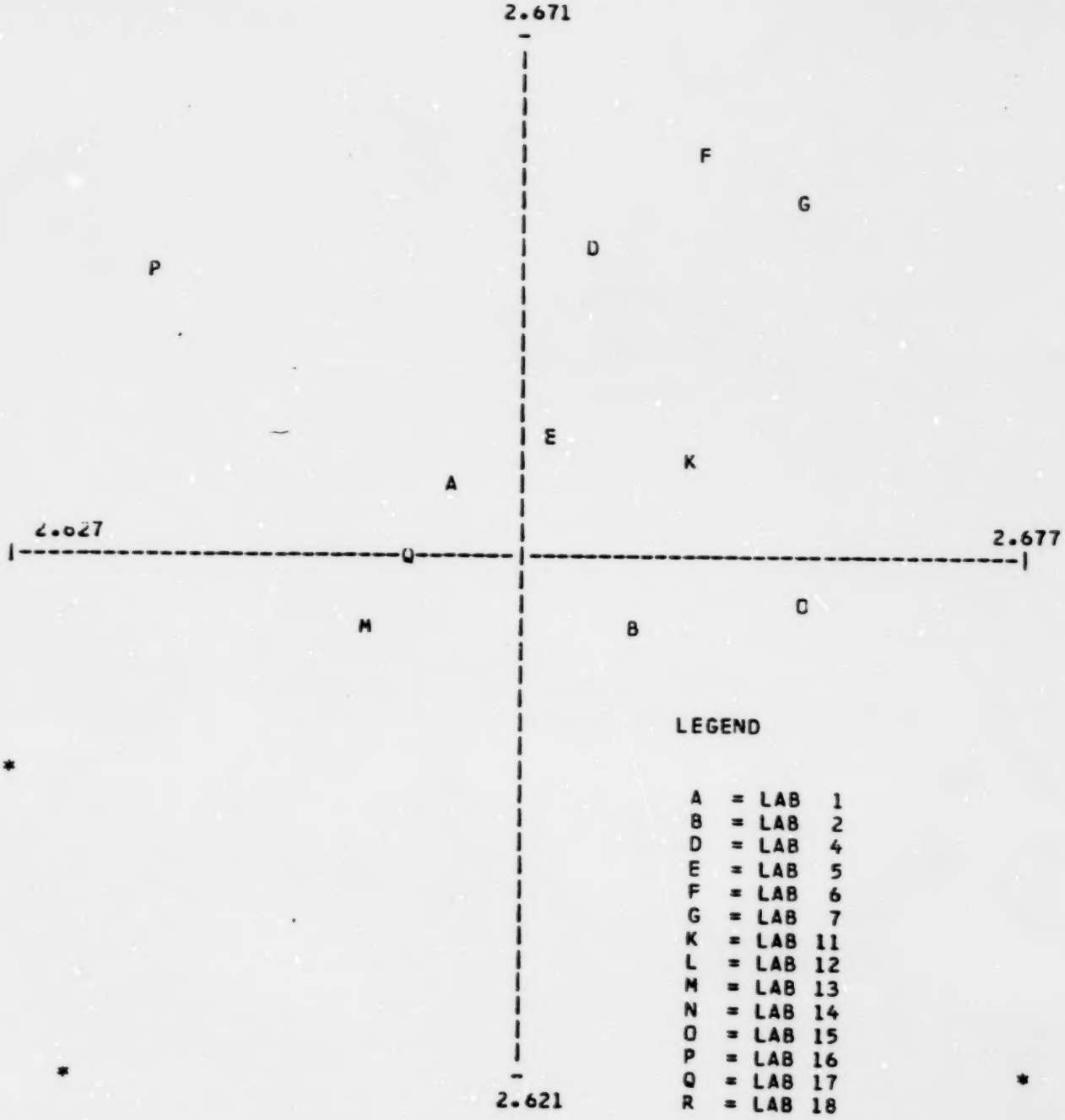
TABLE OF TEST RESULTS

	MATERIAL 1		MATERIAL 2	
LAB 1 OPERATOR 1	2.648	2.648	2.649	2.649
LAB 2 OPERATOR 1	2.657	2.657	2.643	2.643
LAB 4 OPERATOR 1	2.655	2.655	2.661	2.661
LAB 5 OPERATOR 1	2.653	2.653	2.652	2.652
LAB 6 OPERATOR 1	2.661	2.661	2.666	2.666
LAB 7 OPERATOR 1	2.666	2.666	2.663	2.663
LAB 11 OPERATOR 1	2.660	2.660	2.650	2.650
LAB 12 OPERATOR 1	2.678	2.678	2.612	2.612
LAB 13 OPERATOR 1	2.644	2.644	2.643	2.643
LAB 14 OPERATOR 1	2.626	2.626	2.636	2.636
LAB 15 OPERATOR 1	2.666	2.666	2.644	2.644
LAB 16 OPERATOR 1	2.633	2.633	2.660	2.660
LAB 17 OPERATOR 1	2.646	2.646	2.646	2.646
LAB 18 OPERATOR 1	2.629	2.629	2.618	2.618
RANGES	0.052		0.054	

TEST 25: RELATIVE DENSITY(FINE AGGREGATE-BULK)
TEST PERIOD: 81

SCATTER PLOT ANALYSIS
SCALE: 0.003 UNITS=1 CM

HORIZONTAL AXIS: MATERIAL 1
VERTICAL AXIS: MATERIAL 2



LEGEND

A	= LAB	1
B	= LAB	2
D	= LAB	4
E	= LAB	5
F	= LAB	6
G	= LAB	7
K	= LAB	11
L	= LAB	12
M	= LAB	13
N	= LAB	14
O	= LAB	15
P	= LAB	16
Q	= LAB	17
R	= LAB	18

	MATERIAL 1	MATERIAL 2
MEAN	2.652	2.646
STANDARD DEVIATION	0.015	0.016
STANDARD ERROR OF THE MEAN	0.003	0.003

METHODS

OF

PREPARATION AND TESTING

METHOD OF PREPARATION AND TESTING OF BITUMINOUS MIX DESIGN MATERIALS FOR CORRELATION TESTS

SCOPE

This method details the procedures for the preparation, shipping of ingredients and making and testing the specimens for correlation tests. The two complete mixes are first identified by the co-ordinating laboratory. Once identified the co-ordinating laboratory will obtain the necessary samples and by random methods assign the ingredients to the participating laboratories.

ASPHALT MIXES

Each round of the correlation tests involves two mix designs of similar properties. The two mixes will be pretested to identify densities, stabilities, flows and V.M.A The mix proportions will be specified by the co-ordinating laboratory.

Once the two mixes have been identified the materials shall be gathered as follows.-

Coarse Aggregates

Large commercial quarry or gravel source stockpiles shall be used to gather the 25 kg sample bags of coarse and fine materials for each mix.

One 25 kg sample bag of each of the mix A and mix B coarse aggregates for each of P laboratories plus 5 extra bags of each aggregate for storage purposes are required. As the samples are bagged they shall be immediately numbered as follows:-

CA01, CA02.....CA(P+5)

and CB01, CB02.....CB(P+5)

Fine Aggregates

Similarly 25 kg sample bags of each of the two fine aggregates for mix A and mix B will be obtained, bagged and numbered as follows:-

FA01, FA02.....FA(P+5)

and FB01, FB02..... .....FB(P+5)

Asphalt Cement

One litre samples of A.C. shall be made up from 20 litre pails. They shall be poured and numbered in sequence as per correlation testing for asphalt cement see Method of Preparation and Testing of Asphalt Cements for Correlation Testing. The relative density of the A.C. shall be determined by the coordinating laboratory and given to the participating laboratores.

Assignment of Samples to Each Laboratory

By the use of random tables (See Part 4) one sample of each coarse and each fine aggregate will be assigned to each participating laboratory in the following manner:

Select one coarse aggregate mix A for labs 1 to P with one sample being selected for storage after every fifth laboratory until all the laboratories have been assigned one coarse aggregate mix A and the storage samples have been selected. Similarly select samples of fine aggregate mix A. Repeat again for coarse and fine aggregates for Mix B.

Assign in a random fashion two one litre cans of A C. to each laboratory for mixing both mix A and mix B.

	LAB 1	LAB 2	.....	LAB P	STORAGE
MIX A	CA 19 FA 13	CA 08 FA 22		CA 01 FA 24	CA FA CA FA CA FA CA FA CA FA
MIX B	CB 11 FB 17	CB 20 FB 03		CB 18 FB 04	CB FB CB FB CB FB CB FB CB FB
A.C.	AC 03 AC 07	AC 23 AC 11		AC 31 AC 01	AC.... AC....

PACKING

The four aggregate samples and two litres of asphalt cement shall be packed complete with report forms for each laboratory.

SHIPPING

The materials shall be shipped prepaid to the participating laboratories.

PREPARATION OF THE MIXES BY THE PARTICIPATING LABORATORIES

On receipt of the bulk samples of coarse and fine aggregates, dry the samples to constant mass and grade the coarse aggregates.

TESTING

Aggregates

Course and fine aggregates shall be tested for bulk relative density and absorption as per LS 604 and LS 605 respectively. Two determinations for each aggregate are required. The results to be reported on Test Report Form 1.

Mixes

Combine the dried aggregates as per the recipe supplied on the attached mix "Weigh Card" Pages 1-4 and 1-5. MTC laboratory test method LS 261 shall then be followed to prepare the Marshall Specimens. Thereafter the specimens which are made in two groups of three, shall be tested for bulk relative density LS 262, Marshall Properties LS 263, maximum theoretical density LS 264, percent air voids LS 265 and voids in mineral aggregate LS 266.

As the mixing and testing process is most often done by multi-operators all this program is interested in is the six individual results for each mix and each test (12 results per test).

REPORTING OF TEST RESULTS

The test results shall be reported on the forms supplied with the samples (See Appendix Page 1-6). One copy of each report form shall be retained by the laboratory and the others mailed immediately after completion of the tests to the address shown on the form.

WEIGH CARD Mix 'A'

DATE Jan. 28/81

CONTRACT NO. Correl'n '81

% PASS 4.75 mm	% COARSE AND % FINE AGG.	COARSE AGG.GRAD. % CUMULATIVE 1 / COARSE AGG.WT. g CUMULATIVE 2	COARSE AGGREGATE, CA__							FINE, FA__	FINE		% A.C.
			19.0 mm	16.0 mm	13.2 mm	9.5 mm	6.7 mm	4.75 mm	Pass 4.75 mm	AGGREGATE NO.1	AGGREGATE NO.2		
		1				31.5	76.5	95.2		BLEND	BLEND		
55	44.4 / 55.6	2				531	1291	1606	1687	3800			5.1
		2											
		2											
		2											
		2											

ASPHALT SOURCE & GRADE (PENETRATION) AS SUPPLIED IN CORREL'N MIX TYPE

REMARKS

WEIGH CARD Mix 'B'

DATE Jan. 28/81 CONTRACT NO. Correl'n '81

% PASS 4.75 mm	% COARSE AND % FINE AGG.	COARSE AGG. GRAD. % CUMULATIVE 1 / COARSE AGG. WT. g CUMULATIVE 2	COARSE AGGREGATE, CB__							FINE, FB__	FINE		% A.C.
			19.0 mm	16.0 mm	13.2 mm	9.5 mm	6.7 mm	4.75 mm	Pass 4.75 mm	AGGREGATE NO.1	AGGREGATE NO.2		
		1			2.8	37.3	70.7	89.5		BLEND	BLEND		
55	47.4 / 52.6	2			50	672	1273	1612	1801	3800			5.2
		2											
		2											
		2											
		2											

ASPHALT SOURCE & GRADE (PENETRATION) AS SUPPLIED IN CORREL'N MIX TYPE

REMARKS

TEST REPORT FORM 1

INTERLABORATORY BITUMINOUS MIX STUDY

MIX NUMBER A OR B (circle one)

SAMPLE / PROPERTY	1	2	3	4	5	6	REMARKS
Bulk Relative Density							
Max. Relative Density							
M.R.D. (S.D.)							
Percent Voids							
Percent Voids (S.D.)							
Voids in Mineral Agg.,%							
Stability, N							
Flow, 0.025 mm Units							

Bulk Relative Density Coarse Aggregate			Absorption C.A.	
Bulk Relative Density Fine Aggregate			Absorption F.A.	

MAIL RESULTS TO: MINISTRY OF TRANSPORTATION AND COMMUNICATIONS
BITUMINOUS SECTION
ROOM 317, CENTRAL BUILDING,
1201 WILSON AVENUE,
DOWNSVIEW, ONTARIO
M3M 1J8

TESTED BY _____

SIGNATURE _____

DATE COMPLETED _____

TEST REPORT FORM 1

INTERLABORATORY BITUMINOUS MIX STUDY

MIX NUMBER A OR B (circle one)

SAMPLE PROPERTY	1	2	3	4	5	6	REMARKS
Bulk Relative Density							
Max. Relative Density							
M.R.D. (S.D.)							
Percent Voids							
Percent Voids (S.D.)							
Voids in Mineral Agg.,%							
Stability, N							
Flow, 0.025 mm Units							

Bulk Relative Density Coarse Aggregate			Absorption C.A.	
Bulk Relative Density Fine Aggregate			Absorption F.A.	

MAIL RESULTS TO: MINISTRY OF TRANSPORTATION AND COMMUNICATIONS
BITUMINOUS SECTION
ROOM 317, CENTRAL BUILDING,
1201 WILSON AVENUE,
DOWNSVIEW, ONTARIO
M3M 1J8

TESTED BY _____

SIGNATURE _____

DATE COMPLETED _____

METHOD OF PREPARATION AND TESTING OF MIX CONTROL SAMPLES FOR CORRELATION TESTS

SCOPE

This method details the procedures for the preparation, shipping and testing of mix control samples for correlation testing. Each round of the correlation program will involve two different mixes of similar properties. The mixes will be made up by the co-ordinating laboratory as follows:-

PREPARATION OF MIX SAMPLES

The two mixes will be set up to have similar (but not the same) gradings and asphalt contents. The co-ordinating laboratory will choose sufficient quantities of coarse and fine aggregates, mineral filler and asphalt cement to handle the needs for 4P + 20 samples of each mix consisting of 1000g samples. The mineral aggregates will have been dried and graded so that they may be batched as 1000 ± 10g total, samples (including asphalt cement). The asphalt cement will all come from one batch for each mix but may be a different grade. Samples will be numbered in sequence as they are made up into lightly compacted briquettes and will be designated -

M101, M102.....M14P+10

M201, M202.....M24P+10

ASSIGNMENT OF SAMPLES TO EACH LABORATORY

By the use of random tables (see Appendix Pages 4-1 to 4-3) four samples of each mix will be assigned to each of P laboratories in the following manner: Select one number for labs 1 to P from mix 1 with one being selected for storage after every five laboratories, continue until all laboratories have been assigned four samples of mix 1, and until storage has ten samples of mix 1. Repeat the process for mix 2.

LABORATORY	SAMPLES
1.	M117, M119, M206, M221 M101, M122, M233, M204
2.	M112, M127, M223, M237 M133, M107, M218, M241
3.	etc, etc
4.	etc, etc
5.	etc, etc
S.	
6.	
.	
.	
P.	M103, M123, M207, M231 M140, M109, M219, M205
S. (Storage)	M108, M134, etc, etc
	M234, M204, etc, etc

PACKING

The eight samples for each laboratory shall be packed complete with report forms (see Appendix Page 2-4).

SHIPPING

The materials shall be shipped prepaid to the participating laboratories.

TESTING

On receipt of the mix control samples, the eight samples will be tested as per LS 282. The extracted aggregate shall be dried of all solvents as per the lab method and seived. Percent of sample retained on the sieves shall be cumulatively weighed and reported on the report form as per Appendix Page 2-3. The percent retained on the sieves and the asphalt content of each sample will be calculated and reported on the same forms.

Operator 1 will test two samples of mix control 1 and two samples of mix control 2 and report the results under the two left columns under Mix Control 1 and 2 respectively.

Similarly, operator 2 will test the remaining two samples of mix control 1 and mix control 2 and report in the right hand columns of Mix Control 1 and 2 respectively.

Special Note: Use only one bowl and its matching lid for all eight samples.
IF THERE IS ONLY ONE OPERATOR IN YOUR LABORATORY HE/SHE SHALL TEST ALL EIGHT SAMPLES.

REPORTING OF TEST RESULTS

The test results shall be reported on the forms supplied with one copy retained by each of the participating laboratories.

Any questions concerning the testing and reporting of the test results, please contact either M Noga at 248-3500, or J.I. McDougall at 248-3688.

TEST REPORT FORM

LABORATORY NO: _____ LABORATORY NAME: _____ ADDRESS: _____

MAIL RESULTS TO: MINISTRY OF TRANSPORTATION AND COMMUNICATIONS
BITUMINOUS SECTION
ROOM 317, CENTRAL BUILDING
1201 WILSON AVENUE
DOWNSVIEW, ONTARIO
M3M 1J8

TEST		MIX CONTROL 1				MIX CONTROL 2			
		M1__	M1__	M1__	M1__	M2__	M2__	M2__	M2__
MASS OF SAMPLE,g									
MASS OF AGGREGATE,g									
MASS OF ASPHALT CEMENT,g									
A.C.% by mass									
	26.5 mm								
	22.4 mm								
	19.0 mm								
	16.0 mm								
	13.2 mm								
	9.5 mm								
	6.7 mm								
	4.75 mm								
	2.36 mm								
	1.18 mm								
	600 um								
	300 um								
	150 um								
	75 um								
OPERATOR		1		2		1		2	

OPERATOR 1 TESTED BY _____ OPERATOR 2 TESTED BY _____

SIGNATURE _____ SIGNATURE _____

DATE COMPLETED _____ DATE COMPLETED _____

POOR

QUALITY

ORIGINAL